



AGRICULTURAL RESEARCH INSTITUTE  
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# PROCEEDINGS

OF THE

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OF THE

## ZOOLOGICAL SOCIETY

OF LONDON.

1912, pp. 505-913,

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# LIST OF CONTENTS.

1912, pp. 505-913.

## EXHIBITIONS AND NOTICES.

	Page
The SECRETARY. Report on the Additions to the Society's Menagerie during the months of February and March 1912.....	555
Mr. R. I. Pocock, F.R.S., F.L.S., F.Z.S. Exhibition of lantern-slide of two Polar Bear cubs ( <i>Ursus maritimus</i> ) born in the Gardens .....	556
Mr. C. Tate Regan, M.A., F.Z.S. Exhibition of lantern-slides of a Flatfish ( <i>Platophrys nodas</i> ), showing its power of changing its colour and markings.....	556
Dr. R. W. Shufeldt, C.M.Z.S. Exhibition of skins of two Virginia Opossums ( <i>Didelphis virginiana</i> ) .....	556
Mr. D. Seth-Smith, F.Z.S. Exhibition of lantern-slides of the display of the male Peacock Pheasant ( <i>Polyplectron chinquis</i> ). Also of photographs of the young <i>Cariama cristata</i> hatched and reared in the Gardens. (Pl. LXIX.)	557
The SECRETARY. Exhibition of a living specimen of a young female Dorsal Hyrax ( <i>Dendrohyrax dorsalis</i> ) .....	671

	Page
The SECRETARY. Exhibition of photographs of an Elephant Kraal in Siam.....	671
Mr. R. I. Pocock, F.R.S., F.L.S., F.Z.S. Exhibition of a skin and a living specimen of a fawn variety of the Brown Rat ( <i>Epinomys norvegicus</i> ) .....	671
Mr. D. SETH-SMITH, F.Z.S. Exhibition of epidermal sheaths shed from the base of the lower mandible of the King Penguin ( <i>Aptenodytes pennanti</i> ) .....	671
Dr. FRANCIS WARD, F.Z.S. Demonstration, illustrated by lantern-slides and the cinematograph, of a method of observation of fishes, birds, and mammals under water .....	672
The SECRETARY. Report on the Additions to the Society's Menagerie during the month of April 1912 .....	806
Mr. A. BLAYNEY PERCIVAL, F.Z.S. Exhibition of photographs and lantern-slides of Game Animals from British East Africa .....	806
Mr. D. SETH-SMITH, F.Z.S. Exhibition of two living specimens of the Lory ( <i>Calliptilus solitarius</i> ), from Fiji .....	806
Mr. G. A. BOULENGER, F.R.S., F.Z.S. Notice of a paper entitled "Second Contribution to our Knowledge of the Varieties of the Wall-Lizard" .....	807
Mr. E. G. BOULENGER, F.Z.S. Exhibition of a clay-ball containing a cocoon of the African Lung-fish ( <i>Proto- pterus annectens</i> ).....	807
Mr. E. G. B. MEADE-WALDO and Others. Discussion on the Preservation of the Native Fauna of Great Britain ...	807
The SECRETARY. Report on the Additions to the Society's Menagerie during the months of May, June, July, August, and September 1912 .....	908
Mr. R. LYDEKKER, F.R.S., F.Z.S. Note stating that " <i>Gazella hayi</i> " = <i>Gazella fuscifrons</i> .....	911

	Page
The Rev. T. R. R. STEBBING, M.A., F.R.S., F.Z.S. Notice of a memoir on the Crustacea Isopoda collected by the 'Porcupine' Expedition in 1869-1870 .....	912
Mrs. ROSE HAIG THOMAS, F.Z.S. Exhibition of, and remarks upon, the Eggs of <i>Phasianus formosanus</i> , <i>P. versicolor</i> , and their F. 1 and F. 2 offspring. (Text-fig. 126.) ...	912
Sir EDMUND G. LODER, Bt., V.P.Z.S. Demonstration of the capacity of the electric lantern presented by him to the Society.....	913

## P A P E R S.

---

26. Observations on some Alcyonaria from Singapore, with a brief Discussion on the Classification of the Family Nephthyidæ. By EDWARD W. SHANN, B.Sc., Demonstrator and Assistant Lecturer in Zoology in the Victoria University of Manchester. (Pls. LXI.-LXIII.) ..... 505
27. Some early Fossil Cirripedes of the Genus *Scalpellum*. By THOMAS H. WITHERS, F.G.S. (Text-figs. 64 & 65.) 528
28. Experimental Pheasant-breeding. By ROSE HAIG THOMAS, F.Z.S. (Pls. LXIV.-LXVII.) ..... 539
29. A List of Moths of the Family Pyralidæ collected by Felix B. Pratt and Charles B. Pratt in Dutch New Guinea in 1909-10; with Descriptions of new Species. By Sir GEORGE H. KENRICK, F.Z.S. (Pl. LXVIII.) , 546
30. On a rare Stag (*Cervus wallichii*) from Nepal recently presented to the Zoological Society by His Majesty King George. By R. I. Pocock, F.R.S., F.L.S., F.Z.S., Superintendent of the Gardens. (Text-figs. 66-71.)... 558

	Page
31. Contributions to the Anatomy and Systematic Arrangement of the Cestodea.—IV. On a Species of <i>Inermicapsifer</i> from the Hyrax, and on the Genera <i>Zschokkeella</i> , <i>Thysanotenia</i> , and <i>Hydracotenia</i> . By FRANK E. BEDDARD, M.A., D.Sc., F.R.S., F.Z.S., Prosector to the Society. (Text-figs. 72-83.)	576
32. Additional Notes on the Living Specimens of the Australian Lung-fish ( <i>Ceratodus forsteri</i> ) in the Collection of the Zoological Society of London. By BASHFORD DEAN. (Text-figs. 84 & 85.)	607
33. The Circulatory System of the Common Grass-Snake ( <i>Tropidonotus natrix</i> ). By CHAS. H. O'DONOGHUE, B.Sc., F.Z.S., Assistant to the Jodrell Professor of Zoology, University College, London. (Pls. LXX.—LXXII. and Text-figs. 86-91.)	612
34. A First Account of the Courtship of the Redshank ( <i>Totanus calidris</i> ). By JULIAN S. HUXLEY, Lecturer of Balliol College, Oxford	647
35. Some Brackish-water Amphipoda from the Mouths of the Weser and the Elbe, and from the Baltic. By E. W. SEXTON, Marine Biological Laboratory, Plymouth. (Pls. LXXIII. & LXXIV.)	656
36. Descriptions of new Fishes of the Family Loricariidæ in the British Museum Collection. By C. TATE REGAN, M.A., F.Z.S. (Pls. LXXV.—LXXVII.)	666
37. On a Collection of Fishes made by Mr. A. Blayney Percival in British East Africa to the East of Lake Baringo. By G. A. BOULENGER, F.R.S., F.Z.S. (Pls. LXXVIII.—LXXX.)	672
38. Contributions to the Anatomy and Systematic Arrangement of the Cestodea.—V. On a new Genus ( <i>Dasyurotenia</i> ) from the Tasmanian Devil ( <i>Dasyurus ursinus</i> ), the type of a new Family. By FRANK E. BEDDARD, M.A., D.Sc., F.R.S., F.Z.S., Prosector to the Society. (Text-figs. 92-101.)	677
39. Studies in the Fossorial Wasps of the Family Scoliidæ, Subfamilies Elidinae and Anthoboscinae. By ROWLAND E. TURNER, F.Z.S., F.E.S. (Pls. LXXXI.—LXXXIII.)	696

40. Notes on the Spanish Ibex. By ABEL CHAPMAN, F.Z.S. 754
41. The Local Races of Burchell's Zebra. By Major J. STEVENSON-HAMILTON, C.M.Z.S., Game Warden of the Transvaal. (Text-figs. 102-106.)..... 757
42. On *Dipteropeltis*, a new Genus of the Crustacean Order Branchiura. By W. T. CALMAN, D.Sc., F.Z.S. (Pl. LXXXIV.)..... 763
43. On two new Larval Trematodes from the Striped Snake (*Tropidonotus ordinatus sirtalis*). By WILLIAM NICOLL, M.A., D.Sc., M.D., F.Z.S., Lister Institute of Preventive Medicine, London. (Text-fig. 107.) ..... 767
44. A Note on the rare British Nudibranch *Hancockia eudactylota* Gosse. By Sir CHARLES ELIOT, K.C.M.G., C.B., F.Z.S. (Pl. LXXXV.) ..... 770
45. The North Rhodesian Giraffe. By R. LYDEKKER, F.R.S., F.Z.S. (Pl. LXXXVI.) ..... 771
46. On Antler-Growth in the Cervidæ, with special reference to *Elaphurus* and *Odocoileus* (*Dorcylaphus*). By R. I. Pocock, F.R.S., F.L.S., F.Z.S., Superintendent of the Gardens and Curator of Mammals. (Text-figs. 108-112.) ..... 773
47. Polychæta from the Pacific Coast of North America.—Part I. SERPULIDÆ, with a Revised Table of Classification of the Genus *Spirorbis*. By HELEN L. M. PIRELL, B.Sc., F.Z.S., Demonstrator of Zoology and Reid Fellow, Bedford College, University of London. (Pls. LXXXVII.-LXXXIX.)..... 784
48. The One-sided Reduction of the Ovaries and Oviducts in the Amniota, with Remarks on Mammalian Evolution. By HANS GADOW, M.A., Ph.D., F.R.S., F.Z.S. 808
49. Contributions to the Anatomy and Systematic Arrangement of the Cestoidea.—VI. On an Asexual Tapeworm from the Rodent, *Fiber zibethicus*, showing a new form of Asexual Propagation, and on the supposed Sexual Form. By FRANK E. BEDDARD, M.A., D.Sc., F.R.S., F.Z.S., Prosector to the Society. (Text-figs. 113-121.) 822

50. On two new Trematode Parasites from the Indian Cobra. By WILLIAM NICOLL, M.A., D.Sc., M.D., F.Z.S., Lister Institute of Preventive Medicine, London. (Text- figs. 122.) .....	851
51. Statistical Note on the Worm Parasites collected from the Animals dying in the Zoological Gardens from December 1910 till April 1912. By WILLIAM NICOLL, M.A., D.Sc., M.D., F.Z.S., Lister Institute of Pre- ventive Medicine, London .....	856
52. On some new Fossil Reptiles from the Permian and Triassic Beds of South Africa. By R. BROOM, D.Sc., C.M.Z.S. (Pls. XC-XCIII.) .....	859
53. On the Hydrocoralline Genus, <i>Errina</i> . By Professor S. J. HICKSON, F.R.S., F.Z.S., The University of Manchester. (Pls. XCIV.-XCVI.) .....	876
54. Descriptions of new Butterflies of the Genus <i>Thecla</i> from S.E. Brazil. By E. DUKINFIELD JONES, F.Z.S., F.E.S. (Pl. XCVII.) .....	896
55. The Bornean Bantian. By R. LYDEKKER, F.R.S., F.Z.S. (Text-figs. 123-125.) .....	902
56. Notes on the Breeding of the "Millions" Fish ( <i>Gir- ardinus pectiloides</i> ). By EDWARD G. BOULENGER, F.Z.S., Curator of Reptiles .....	906
Alphabetical List of Contributors .....	ix
New Generic Terms .....	xvi
Index of Scientific Names .....	xvii
Index of Illustrations .....	xxvi

# ALPHABETICAL LIST

OF THE

## CONTRIBUTORS,

*With References to the several Articles contributed by each.*

(1912, pp. 505-913.)

	Page
BEDDARD, FRANK E., M.A., D.Sc., F.R.S., F.Z.S., Prosector to the Society.	
Contributions to the Anatomy and Systematic Arrangement of the Cestoidea.—IV. On a Species of <i>Inermicapsifer</i> from the Hyrax, and on the Genera <i>Zschokkeella</i> , <i>Thysanotenia</i> , and <i>Hyracotenia</i> . (Text-figs. 72-83.) ...	576
Contributions to the Anatomy and Systematic Arrangement of the Cestoidea.—V. On a New Genus ( <i>Dasyurotenia</i> ) from the Tasmanian Devil ( <i>Dasyurus ursinus</i> ), the type of a new Family. (Text-figs. 92-101.).....	677
Contributions to the Anatomy and Systematic Arrangement of the Cestoidea.—VI. On an Asexual Tapeworm from the Rodent, <i>Fiber zibethicus</i> , showing a new form of Asexual Propagation, and on the supposed Sexual Form. (Text-figs. 113-121.) .....	822



BOULENGER, EDWARD G., F.Z.S., Curator of Reptiles.

Exhibition of a clay-ball containing a cocoon of the  
African Lung-fish (*Protopterus annectens*) ..... 807

Notes on the Breeding of the "Millions" Fish  
(*Girardinus pœciloides*) ..... 906

BOULENGER, GEORGE A., F.R.S., F.Z.S.

On a Collection of Fishes made by Mr. A. Blayney  
Percival in British East Africa to the East of Lake  
Baringo. (Pls. LXXVIII.-LXXX.) ..... 672

Notice of a paper entitled "Second Contribution to  
our Knowledge of the Varieties of the Wall-Lizard" ... 807

BROOM, ROBERT, D.Sc., C.M.Z.S.

On some new Fossil Reptiles from the Permian and  
Triassic Beds of South Africa. (Pls. XC.-XCIII.) ..... 859

CALMAN, WILLIAM T., D.Sc., F.Z.S.

On *Dipteropeltis*, a new Genus of the Crustacean Order  
Branchiura. (Pl. LXXXIV.) ..... 763

CHAPMAN, ABEL, F.Z.S.

Notes on the Spanish Ibex ..... 754

DEAN, BASHFORD, Ph.D.

Additional Notes on the Living Specimens of the  
Australian Lung-fish (*Ceratodus forsteri*) in the Col-  
lection of the Zoological Society of London. (Text-  
figs. 84 & 85.) ..... 607

ELIOT, Sir CHARLES, K.C.M.G., C.B., F.Z.S.

A Note on the rare British Nudibranch *Hancockia*  
*eudactylota* Gosse. (Pl. LXXXV.) ..... 770

	Page
GADOW, HANS, M.A., Ph.D., F.R.S., F.Z.S.	
The One-sided Reduction of the Ovaries and Oviducts in the Amniota, with Remarks on Mammalian Evolution.	808
HAMILTON, Major J. STEVENSON-. See STEVENSON-HAMIL- TON, J.	
HICKSON, Professor SYDNEY J., D.Sc., F.R.S., F.Z.S., The University of Manchester.	
On the Hydrocoralline Genus, <i>Errina</i> . (Pls. XCIV.- XCVI.) .....	876
HUXLEY, JULIAN S., Lecturer of Balliol College, Oxford.	
First Account of the Courtship of the Redshank ( <i>Totanus calidris</i> ) .....	647
JONES, E. DUKINFELD, F.Z.S., F.E.S.	
Descriptions of new Butterflies of the Genus <i>Thecla</i> from S.E. Brazil. (Pl. XCVII.) .....	896
KENRICK, Sir GEORGE H., F.Z.S.	
A List of Moths of the Family Pyralidæ collected by Felix B. Pratt and Charles B. Pratt in Dutch New Guinea in 1909-10; with Descriptions of new Species. (Pl. LXVIII.) .....	546
LODER, Sir EDMUND G., Bart., V.P.Z.S.	
Demonstration of the capacity of the electric lantern presented by him to the Society .....	913
LYDEKKER, RICHARD, F.R.S., F.Z.S.	
The North Rhodesian Giraffe. (Pl. LXXXVI.) .....	771
The Bornean Bantin. (Text-figs. 123-125.) .....	902
Note stating that " <i>Gazella hayi</i> " = <i>Gazella fuscifrons</i> .....	911

	Page
MEADE-WALDO, EDMUND G. B., V.P.Z.S., and Others.	
Discussion on the Preservation of the Native Fauna of Great Britain .....	807
MITCHELL, P. CHALMERS, M.A., D.Sc., Hon. LL.D., F.R.S., F.Z.S., Secretary to the Society.	
Report on the Additions to the Society's Menagerie during the months of February and March 1912 .....	555
Exhibition of a living specimen of a young female Dorsal Hyrax ( <i>Dendrohyrax dorsalis</i> ) .....	671
Exhibition of photographs of an Elephant Kraal in Siam .....	671
Report on the Additions to the Society's Menagerie during the month of April 1912 .....	806
Report on the Additions to the Society's Menagerie during the months of May, June, July, August, and September 1912 .....	908
NICOLL, WILLIAM, M.A., D.Sc., M.D., F.Z.S., Lister Institute of Preventive Medicine, London.	
On two new Larval Trematodes from the Striped Snake ( <i>Tropidonotus ordinatus sirtalis</i> ). (Text-fig. 107.).	767
On two new Trematode Parasites from the Indian Cobra. (Text-fig. 122.).....	851
Statistical Note on the Worm Parasites collected from the Animals dying in the Zoological Gardens, from December 1910 till April 1912 .....	856
O'DONOGHUE, CHARLES H., B.Sc., F.Z.S., Assistant to the Jodrell Professor of Zoology, University College, London.	
The Circulatory System of the Common Grass-Snake ( <i>Tropidonotus natrix</i> ). (Pls. LXX-LXXII. and Text- figs. 86-91.).....	612

	Page
PERCIVAL, A. BLAYNEY, F.Z.S.	
Exhibition of photographs and lantern-slides of Game Animals from British East Africa .....	806
PIXELL, Miss HELEN L. M., B.Sc., F.Z.S., Demonstrator of Zoology and Reid Fellow, Bedford College, University of London.	
Polychæta from the Pacific Coast of North America.— Part I. SERPULIDÆ, with a Revised Table of Classification of the Genus <i>Spirorbis</i> . (Pls. LXXXVII.–LXXXIX.) .	784
POCKOCK, REGINALD I., F.R.S., F.L.S., F.Z.S., Superintendent of the Gardens and Curator of Mammals.	
Exhibition of lantern-slide of two Polar Bear cubs ( <i>Ursus maritimus</i> ) born in the Gardens .....	556
On a rare Stag ( <i>Cervus wallichii</i> ) from Nepal recently presented to the Zoological Society by His Majesty King George. (Text-figs. 66–71.) .....	558
Exhibition of a skin and a living specimen of a fawn variety of the Brown Rat ( <i>Epimys norvegicus</i> ) .....	671
On Antler-Growth in the Cervidæ, with special reference to <i>Elaphurus</i> and <i>Odocoileus</i> ( <i>Dorcelaphus</i> ). (Text-figs. 108–112.).....	773
REGAN, C. TATE, M.A., F.Z.S.	
Exhibition of lantern-slides of a Flatfish ( <i>Platophrys podas</i> ), showing its power of changing its colour and markings .....	556
Descriptions of new Fishes of the Family Loricariidæ in the British Museum Collection. (Pls. LXXV.–LXXVII.) .....	666

SETH-SMITH, DAVID, F.Z.S., Curator of Birds.

Exhibition of lantern-slides of the display of the male Peacock Pheasant (*Polyplectron chinquis*). Also of photographs of the young *Cariamã cristata* hatched and reared in the Gardens. (Pl. LXIX.) ..... 557

Exhibition of epidermal sheaths shed from the base of the lower mandible of the King Penguin (*Aptenodytes pennanti*) ..... 671

Exhibition of two living specimens of the Lory, *Calliptilus solitarius*, from Fiji ..... 806

SEXTON, Mrs. E. W., Marine Biological Laboratory, Plymouth.

Some Brackish-water Amphipoda from the mouths of the Weser and the Elbe, and from the Baltic. (Pls. LXXIII. & LXXIV.) ..... 656

SHANN, EDWARD W., B.Sc., Demonstrator and Assistant Lecturer in Zoology in the Victoria University of Manchester.

Observations on some Alcyonaria from Singapore, with a brief Discussion on the Classification of the Family Nephthyidæ. (Pls. LXI.-LXIII.) ..... 505

SHUFELDT, ROBERT W., M.D., C.M.Z.S.

Exhibitions of skins of, and remarks upon, two Virginia Opossums (*Didelphis virginiana*) ..... 556

SMITH, DAVID SETH-. See SETH-SMITH, D.

STEBBING, The Rev. THOMAS R. R., M.A., F.R.S., F.Z.S.

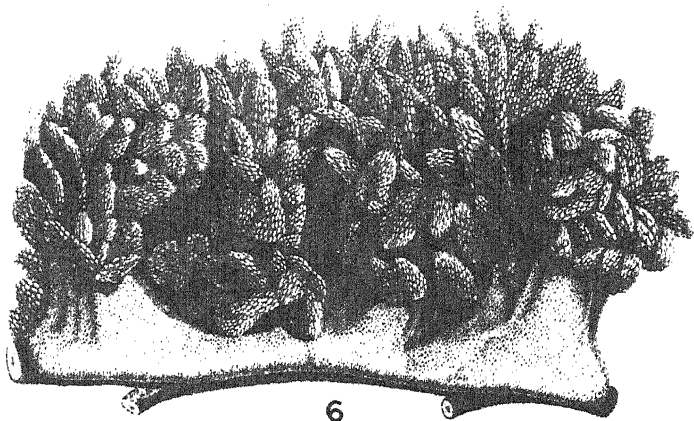
Notice of a Memoir on the Crustacea Isopoda collected by the 'Porcupine' Expedition in 1869-1870. .... 912

	Page
STEVENSON-HAMILTON, Major J., C.M.Z.S., Game Warden of the Transvaal.	
The Local Races of Burchell's Zebra. (Text-figs. 102- 106.).....	757
THOMAS, Mrs. ROSE HAIG, F.Z.S.	
Experimental Pheasant - breeding. (Pls. LXIV.- LXVII.) .....	539
Exhibition of the Eggs of <i>Phasianus formosanus</i> , <i>P. versicolor</i> , and their F. 1 and F. 2 offspring. (Text- fig. 126.) .....	912
TURNER, ROWLAND E., F.Z.S., F.E.S.	
Studies in the Fossorial Wasps of the Family Scoliidae, Subfamilies Elidinae and Anthoboscinae. (Pls. LXXXI.- LXXXIII.).....	696
WALDO, E. G. B. MEADE-. See MEADE-WALDO, E. G. B.	
WARD, FRANCIS, M.D., F.Z.S.	
Demonstration, illustrated by lantern-slides and the cinematograph, of a method of observation of fishes, birds, and mammals under water .....	672
WITHERS, THOMAS H., F.G.S.	
Some early Fossil Cirripedes of the Genus <i>Scalpellum</i> . (Text-figs. 64 & 65.) .....	528

## NEW GENERIC TERMS

PROPOSED IN THE PRESENT VOLUME (pp. 505-913).

	Page		Page
Alopecorhinus (Reptilia) .....	864	Hyracotaenia (Vermes) .....	604
Braunsomeria (Insecta).....	697	Ictidopsis (Reptilia) .....	872
Brevicella (Insecta) .....	549	Protolæospira (Vermes) .....	798
Dasyurotaenia (Vermes) .....	694	Seymnognathus (Reptilia).....	861
Dipteropeltis (Crustacea) .....	763	Taurops (Reptilia) .....	859
Emydochampsia (Reptilia).....	875	Urocystidium (Vermes).....	840
Emydops (Reptilia) .....	871	Xenopharynx (Vermes) .....	851
Galeops (Reptilia) .....	860		



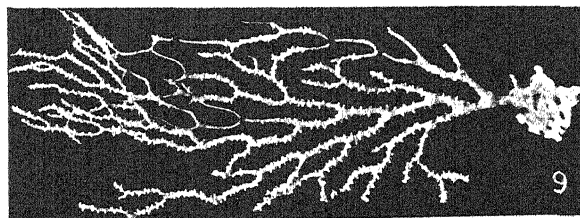
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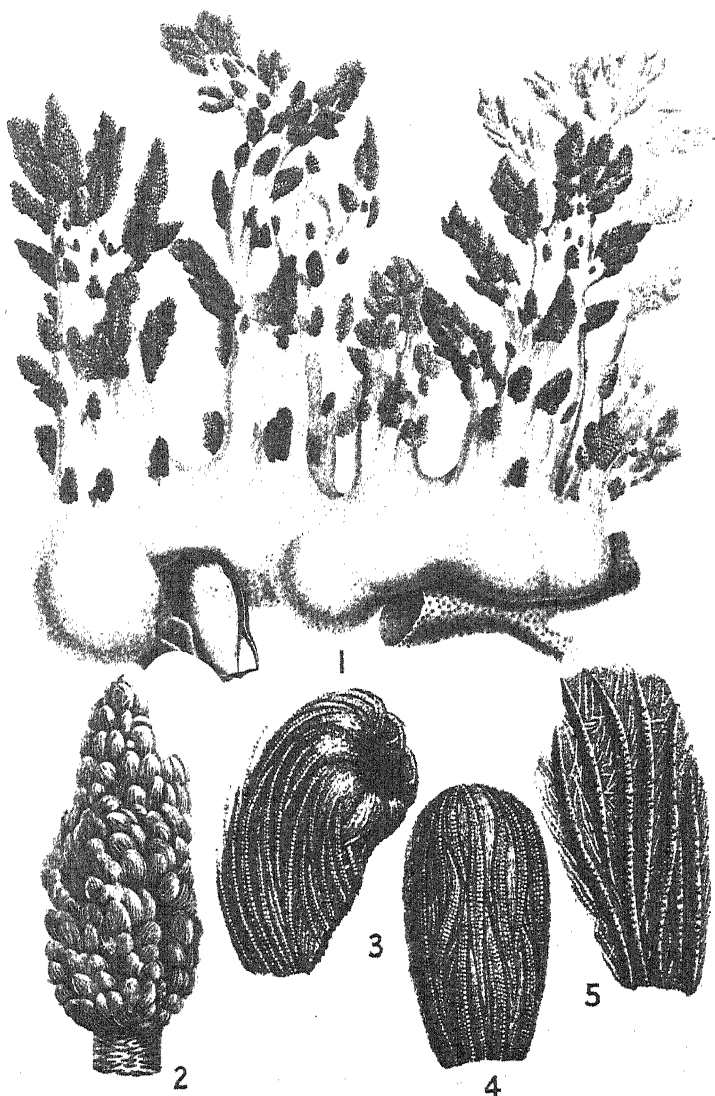
9

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ALCYONARIA FROM SINGAPORE.

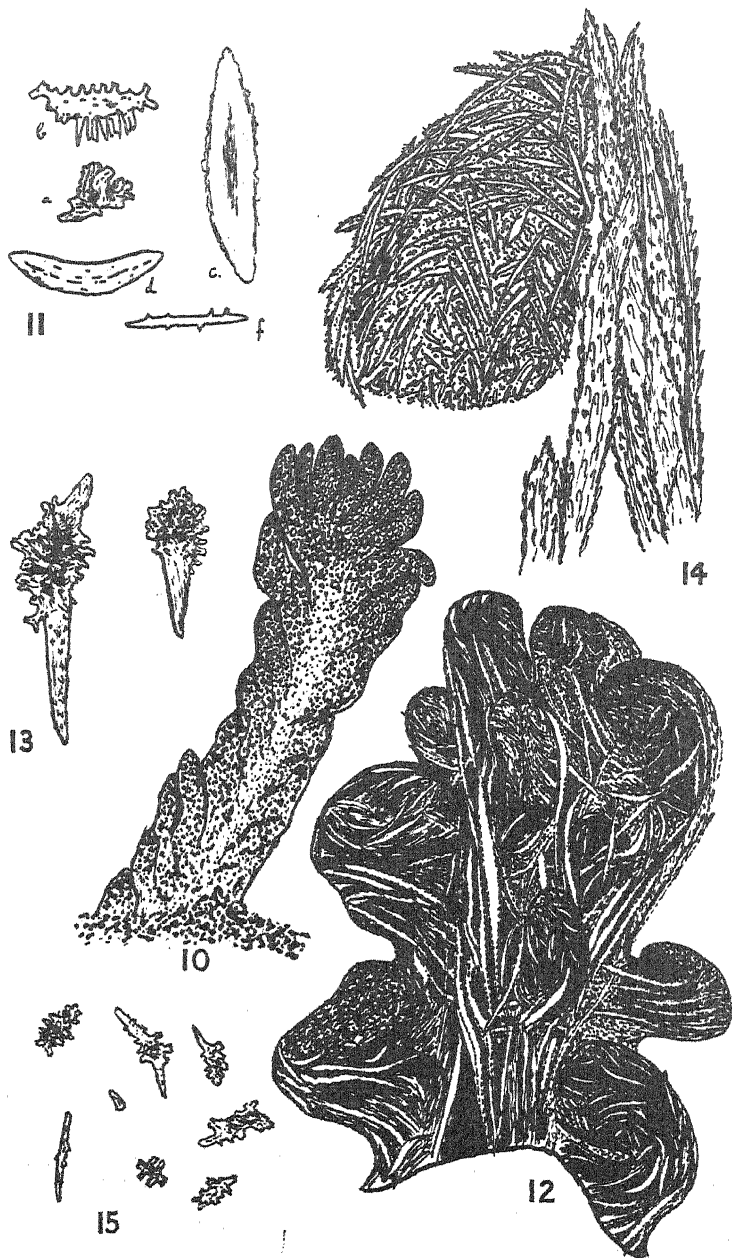






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ALCYONARIA FROM SINGAPORE.



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PAPERS.

26. Observations on some Aleyonaria from Singapore, with a brief Discussion on the Classification of the Family Nephthyidae. By EDWARD W. SHANN, B.Sc., Demonstrator and Assistant Lecturer in Zoology in the Victoria University of Manchester\*.

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(Plates LXI.—LXIII.†)

Systematic :	INDEX.	Page
<i>Sclerophyllum pinnulatum</i> , sp. n. ....		507
<i>Nephthya bedfordi</i> , sp. n. ....		511
<i>Stereonephthya lutea</i> , sp. n. ....		521
<i>Wrightella robusta</i> , sp. n. ....		525
<i>Nephthya</i> : Historical Summary of .....		510
<i>Dendronephthya</i> do. ....		518
<i>Stereonephthya</i> do. ....		520

A collection of Aleyonaria, made by Mr. W. F. Lanchester and the late Mr. F. P. Bedford during their residence in Singapore, was sent to the Zoological Department at the Victoria University of Manchester. Professor S. J. Hickson kindly

\* Communicated by Prof. S. J. Hickson, D.Sc., F.R.S., F.Z.S.

† For explanation of the Plates see p. 527.

entrusted to me the task of identifying the specimens in the collection. The collecting was carried on in shallow water around the coast of Singapore; the precise localities will be cited under the description of the several species. Several examples of Nephthyidae occur, and this necessitated facing the vexed question of the classification of that family; I shall state below my reasons for adopting the scheme of classification advanced by Kükenthal.

I wish to express my indebtedness to Prof. Hickson for his constant advice as to my procedure and help in the pursuit of literature bearing upon the subject. In the last-named branch of the work I had frequent recourse to an exceedingly useful catalogue of the Aleyonaria prepared by Dr. J. Stuart Thomson. My thanks are also due to Mr. J. T. Wadsworth for preparing the excellent photographs from which Plate LXII. figs. 7, 8, & 9 were made.

In all eleven species are described, of which four are new. The systematic positions of the several species are as follows:—

#### Order ALCYONACEA Verrill (*pro parte*).

##### Family ALCYONIDÆ.

*Sclerophytum pinnulatum*, sp. n.

##### Family TELESTIDÆ.

*Telesto rupicola* F. Müller.

##### Family NEPHTHYIDÆ.

*Nephthya bedfordi*, sp. n.

*Dendronephthya disciformis* Kükenth.

*Stereonephthya lutea*, sp. n.

*Paraspongodes crassa* Kükenth.

##### Family SIPHONOGORGIDÆ.

*Siphonogorgia variabilis* Hickson.

#### Order GORGONACEA.

##### Suborder PSEUDAXONIA.

##### Family SCLEROGORGIDÆ.

*Suberogorgia suberosa* Pallas.

##### Family MELITODIDÆ.

*Melitodes albitincta* Ridley.

*Psilacabaria gracillima* Ridley.

*Wrightella robusta*, sp. n.

## Order ALCYONACEA.

## Family ALCYONIIDÆ.

## Genus SCLEROPHYTUM.

*Sc. PINNULATUM*, sp. n. (Pl. LXII. fig. 7; Pl. LXIII. fig. 10.)

A single complete colony was taken just below low-tide mark from Blakang Mati.

In its form and mode of branching the colony closely resembles *Sc. palmatum* Pratt (1903). As in the last-named species, the colony (fig. 7) is erect, branched, and shows a marked lateral compression. The total height is 88 mm., of which the stalk comprises 45 mm. The diameter of the stalk is  $31 \times 11$  mm., and that of the capitulum is  $60 \times 35$  mm. The stalk divides at its distal end into two almost equal primary branches. From these branches spring numerous secondary lobes which are arranged in no definite order. The secondary lobes frequently show lateral compression in their proximal regions, but their terminations are usually bluntly conical, while a few are reniform. The length of these lobes is 12–20 mm., and their diameter 6–9 mm.

The colour of this specimen in alcohol is slate-grey. The consistency is tough; the stem is hard and brittle, but the secondary lobes are soft and fleshy.

The autozooids are of a brown colour and are uniformly scattered over the surface of the secondary lobes. The average distance between two adjacent polyps is .6 mm. Autozooids are also found on the primary branches almost down to the level of the stalk, but in this region the distance between them is very much greater, viz. 3–4 mm. Many of the autozooids are more or less expanded, but none of them are situated on raised rounded areas such as occur in *Sc. palmatum*. The anthocodiae are of medium size when compared with those of the genus *Sclerophytum* as a whole; the diameter of an expanded crown is 1 mm., but the polyp-heads appear only half that size when contracted.

The tentacles (fig. 10) form the distinctive feature of this species. They are .55 mm. in length, compressed, and expanded at the distal end. There is a single row of free well-developed pinnules on each side of a tentacle. The pinnules are .06 mm. in average length, but the larger ones attain a length of .10 mm. and a breadth of .035 mm. The larger pinnules are those which are placed third, fourth, and fifth from the distal end; they become shorter as they approach the base of the tentacle. There are about twelve pinnules in each row.

The stomodæum is long and convoluted. The mesenteries and mesenterial filaments are well marked. No sexual organs were observed.

The siphonozoids, if present, are extremely degenerate. A very few minute diverticula of the superficial canals, which point in the direction of the surface, but never open to the exterior,

may represent rudimentary siphonozoids. The superficial canals form a dense network just beneath the surface of the colony; their diameter is  $\cdot 044\text{--}\cdot 120$  mm. The vessels of the internal system are clearly defined and circular in cross-section, and are fairly numerous.

Zoochlorellæ are numerous in the superficial canal-system, and occur in less abundance in the interior. They are also found in the endoderm of the polyps, and extend into the tentacles, occupying even the lumen of the pinnules.

The spicules are quite characteristic of the genus *Sclerophytum*, and indeed only differ from those of *Sc. palmatum* in almost insignificant detail. The little knotted clubs average  $\cdot 16 \times \cdot 034$  mm., and the spindles are sometimes only  $\cdot 058 \times \cdot 015$  mm. These minute spicules only occur immediately beneath the surface. The spicules of the cœnenchyme are fairly numerous and are all of the tuberculate warted type; they vary considerably, however, in shape and size. The majority are spindles which narrow rapidly towards their ends to rather acute points; their measurements range from  $\cdot 4 \times \cdot 11$  mm. to  $3\cdot 0 \times 45$  mm. Irregularly branched forms are by no means uncommon.

The following considerations are advanced as an apology for the creation of a new species of *Sclerophytum* based on the examination of a single specimen.

This colony had been assigned in a preliminary investigation to the species *Sc. palmatum* Pratt (1903), and at first sight this diagnosis appeared perfectly accurate. The external appearance, and indeed the actual measurements, agree closely with the description of the type specimen. The characters and distribution of the spicules, the well-marked mesenteries and mesenterial filaments, the rudimentary condition of the siphonozoids, the orientation of the canal-systems, and the distribution of the zoochlorellæ, all tend to enhance the resemblance between the two species. It is only when the autozooids are examined that the true specific difference is realized; those of *Sc. palmatum* are distinctly larger than those of *Sc. pinnulatum*. The characters of the tentacles which form the essential divergence of the two species are tabulated below:—

<i>Sc. palmatum</i> Pratt.	<i>Sc. pinnulatum</i> , sp. n.
·7 mm. in length.	·55 mm. in length.
Almost of uniform length.	Expanded at distal end.
Possess a double row of rudimentary pinnules down each side.	A single row of free well-developed pinnules down each side.

*Sc. pinnulatum* could be confounded with no other species of *Sclerophytum*. At the same time, it is of interest to note that a single row of free pinnules has been recorded on either side of the tentacles of *Sc. viride* by Thomson and Henderson (1906). The possession of free pinnules, now recorded for two species of

*Sclerophyllum*, tends to strengthen the relationship of the genera *Sclerophyllum* and *Xenia* which has been suggested by Pratt (1903).

## Order ALCYONACEA.

### Family TELESTIDÆ.

#### Genus TELESTO.

##### *T. RUPICOLA* F. Müller.

*Carijoo rupicola* F. Müller, Arch. Naturg., Jg. 33, 1867, p. 33, tab. 9. figs. 56 & 57.

*Telesto (Carijoo) rupicola* Wright & Studer, 'Challenger' Reports, Zool. vol. xxxi. 1889, p. 262.

*Telesto rupicola* May, Jena Zeitschr. Naturw. vol. xxvi. 1900, p. 58.

*Telesto rupicola* Hickson & Hiles, Willey's Zoolog. Res. 1900, p. 496, tab. 50. figs. 1 & 2.

*Telesto rupicola* Thomson & Henderson, Marine Fauna of Zanzibar, 1906, p. 434.

*Telesto rupicola* H. Laackmann, Zoolog. Jahrb. Supp. 11, Heft 1, 1908, p. 81, Taf. 2. figs. 1, 2; Taf. 3. fig. 3.

Although the only species of *Telesto* previously recorded from Singapore is *T. prolifera* v. Koch, the numerous small colonies in this collection appear to bear a closer resemblance to *T. rupicola*, and are therefore described under that name.

The largest of these colonies is of a grey hue. Its longest axial polyp measures 85 mm. in length, it is 3 mm. in diameter at the base and 1.25 mm. at the top. It bears six lateral polyps, the longest of which measures 24 mm. Anthocodia arise at frequent, but pretty regular intervals, both from the axial and lateral polyps; their average length is 3 mm., and breadth 1.5 mm. The majority of the other specimens are pale yellow and of smaller size. All these forms were obtained in shallow water near Singapore. Some of the exact localities read as follows: Pulo Brani, 6 fms.; Pulo Brani, 5-10 fms.; Blakang Mati, below low tides; Tanjong Pagar, 10 fms.

Previously recorded from Rio de Janeiro (F. Müller); Brazilian coast (Munich Museum); Blanche Bay, New Britain (Hickson & Hiles); Zanzibar (Thomson & Henderson); Bahia ('Challenger').

The spicules show a very wide variety of forms. Not only is this the case, but a different selection of spicules was found in each of the five specimens examined.

One specimen contained spicules very much resembling those of *T. riisei*. Indeed, the two species are probably very closely related, for Laackman (*op. cit.* pp. 72 & 82) is at some pains to distinguish between them. It should be remembered, however, that *T. riisei* has not yet been recorded from the Old World.

A very small specimen of a pale yellow colour was examined



and found to bear many points of resemblance with *T. prolifera*; the spicules, for instance, agree well with those figured by Lauckmann for that species (*op. cit.* p. 87), and the stem walls are very thin. At the same time, it was taken from the same locality (Pulo Braui) as one of the larger specimens which undoubtedly belongs to the species *T. rupicola*. Moreover, another specimen was intermediate in every particular between the above exceptional form and the larger examples, which had been assigned without difficulty to *T. rupicola*. As this small specimen was evidently very young, one would not wish to attach too deep a significance to the observations made or to draw any hasty conclusions from them. At the same time, it is well within the range of possibility that the accumulation of such knowledge may lead eventually to a reduction in the number of species of *Telesto*.

An Historical Summary of the Genera *Nephthya*, *Dendronephthya*, and *Stereonephthya*, with reasons for retaining the definitions of these genera of the family Nephthyidae as enumerated by Kükenthal.

#### Genus NEPHTHYA Savigny.

1817. *Nephthée* Savigny, Descr. de l'Égypte, Hist. Nat. Suppl. i. Atlas, Polypes, tab. 2. fig. 5.
1828. *Nephthya* Audouin, Explication sommaire des Planches de polypes de l'Égypte et de la Syrie, publiées par Jules-César Savigny dans: Description de l'Égypte, vol. xxiii. Paris.
1834. *Nephthya* Ehrenberg, Die Corallenthiere des Rothen Meeres, p. 284.
1846. *Nephthya* Dana, 'Zoophytes,' Philadelphia, p. 610.
1857. *Nephthya* Milne-Edwards, Histoire Naturelle des Corallaires, vol. i. p. 127.
1877. *Nephthya* Klunzinger, Die Korallthiere des Rothen Meeres, Th. 1, p. 33.
1887. *Nephthya* Studer, in Arch. Naturg., Jg. 53, vol. i. pp. 19, 20.
1887. *Nephthya* (pars), Danielssen, in Norske Nordhavs Exp. vol. v. p. 82.
1889. *Nephthya* and *Spongodes* (pars) Wright & Studer, 'Challenger' Reports, Zoology, vol. xxxi. p. xxv.
1895. *Spongodes* (pars) Holm, in Zool. Jahrb., Bd. 8, p. 24.
1895. *Spongodes* (pars) Kükenthal, in Zool. Anz., Jg. 18, p. 428.
1896. *Nephthya* Kükenthal, in Abh. Senckenb. Ges. Frankfurt, vol. xxiii. pp. 89-91.
1899. *Nephthya* May, in Jena Zeitschr. Naturw. vol. xxxiii. p. 156.
1903. *Nephthya* Kükenthal, in Zool. Jahrb., Bd. 19, p. 141.

In 1817 Savigny described two genera of Nephthyidae to which he gave the names *Ammothée* and *Nephthée*. Audouin (1828),

to whom fell the task of describing Savigny's plates, believed that Savigny's Tab. 1. fig. 8 represented *Ammothée*, and that Tab. 2. figs. 5 & 6 represented *Nephthée*. The genus *Nephthea*, as the author wrote it, was recognised by Ehrenberg (1834); but at the same time he disputed the interpretation of Savigny's plates, maintaining that Audouin had given the name *Nephthea cordierii* to the form, represented in Tab. 2. fig. 6, which Savigny had intended to call *Ammothée*. Ehrenberg's view has been accepted by all subsequent authors, and it is now generally agreed that Tab. 2. fig. 5, correctly designated by Audouin *Nephthea chabrolii*, represents the type of Savigny's genus *Nephthée*, while Tab. 2. fig. 6 represents his type of the genus *Ammothée*, namely *A. virescens*. There can be no reasonable doubt with regard to the authenticity of origin of the genus *Nephthya*, that is to say, that the genus was based on the description of the species *N. chabrolii*, which is figured in Savigny's Tab. 2. fig. 5. In the case of *Ammothée*, or *Ammothea* as the genus was known for many years, the name was changed to *Lithophytum* by Kükenthal (1903), since that author found that Savigny's type species, *A. virescens*, is identical with a form described forty-two years previously by Forskål under the name *Lithophyton arboreum*; in deference to the International Rules of Zoological Nomenclature the older name must be retained. Thus it is of little moment whether or not Ehrenberg was justified in disputing Audouin's interpretation of Tab. 2. fig. 6.

Copies of Savigny's plates are extremely scarce, so that it is not always possible for the research worker to examine the original figures; many have probably been compelled to content themselves with descriptions by other authors. With this difficulty in view, Professor Bourne very kindly had photographs taken for Professor Hickson from Savigny's plates, Tab. 2. figs. 5 & 6, in the Radcliffe Library at Oxford. Prof. Hickson has given me permission to publish these figures in this paper, so that they may be readily accessible to all workers on the Nephthyidae. They are reproduced in Pl. LXI. figs. 1-5 and Pl. LXII. fig. 6.

Ehrenberg (1834) distinguished *Nephthya* from *Ammothea* by the prominence of the polyp-spicules in the former genus, for he says of *Nephthya*:—"polypis in verrucas inermes retractilibus." We see, then, that Ehrenberg recognised the distinction between the genera *Nephthya* and *Lithophytum* (*Ammothea*) which obtains at the present day, namely the presence and absence of armed polyps (polyps with "Stützbündel") in these genera respectively. Ehrenberg's definition of *Nephthya* was recognised by Dana (1846), Milne-Edwards (1857), Klunzinger (1877), Studer (1887), and Danielssen (1887). The numerous new species described during this period were distinguished by their authors, on the one hand from *Ammothea* by the presence of armed verrucæ, and on the other from *Spongodes* Less. by the comparatively slight development of the spicules which formed the armament of

the verrucae. Wright and Studer (1889) described a specimen under the name *Spongodes nephthyaformis*, concerning which they observe:—"The entire habit of the colony recalls much more that of *Nephthya* than that of *Spongodes*, and this impression is strengthened by the slight development of the spicules surmounting the little heads, whence the colony does not appear so prickly as other species . . . . The species must be referred to the genus *Spongodes*, because the polyps are placed sideways within a bundle of spicules, although these only project slightly." That is to say, Wright and Studer recognised on the anthocodiae of *Sp. nephthyaformis* the presence of what is now known as a "Stützbündel," and here we have the starting-point of the difficulty of discriminating between the genera *Spongodes* and *Nephthya*. Holm (1895) faced the problem of reconstructing the genus *Spongodes* in the light of the knowledge which had accumulated since Lesson first described the genus in 1834. This author pointed out that *Spongodes nephthyaformis* W. & St. is identical with *Nephthya chabrolii* Audouin, and added that *N. chabrolii* differs from *Spongodes* in many characters, such as the branching of the colony and the arrangement of the polyps: on these characters one can establish two genera, but it is necessary then to add to the genus *Nephthya* many species hitherto included in the genus *Spongodes*, including the type *Sp. celosia*. Though Holm shrank from submitting a well-known type like *Spongodes celosia* to such treatment, he proceeded fearlessly to include all the species of *Nephthya*, including the type *N. chabrolii*, within the genus *Spongodes*; he retained *Nephthya*, however, as a subgeneric title. Here was a step in the direction of elucidation; *Nephthya* and *Spongodes*, as hitherto defined, were shown to be synonymous; but Holm's solution of the problem threw too great a burden on *Spongodes*. Kükenthal (1895), writing during the year in which Holm's paper was published, accepted the genus *Spongodes* in its new distended form; but the term *Spongodes* had become so obviously cumbersome that this author (Kükenthal), in a later paper\*, reinstated *Nephthya* with full generic honours. In this paper Kükenthal gave a summary of the family Nephthyidae, and divided the various genera into two groups as they possessed or lacked a "Stützbündel"; he summed up his remarks as follows:—"Innerhalb der Familie der Nephthyiden ist als wichtigstes Merkmal zu betrachten, ob die Polypenköpfchen terminal auf ihrem unteren Teile, dem Stiele, sitzen oder seitlich davon. Letzterer Fall tritt stets dann ein, wenn sich auf einer Seite, der oberen, ein Bündel Spicula besonders stark entwickelt: das Stützbündel." The genera possessing a "Stützbündel" were distinguished from one another by the disposition of the polyps on the colony, as Holm (1895) had already suggested; the name *Nephthya* was applied to forms resembling the original type *N. chabrolii* Audouin, in which the polyps are collected on branchlets, the latter being arranged in catkins or lappets, and the name *Spongodes* was

\* Abh. Senckenb. Ges. Frankfurt, vol. xxiii. p. 88 (1896).

retained for forms in which the polyps are disposed sporadically or in bundles. The net result of this reformation was the inclusion in the genus *Nephthya* of all forms hitherto included in the "Spicate" group of the genus *Spongodes*.

In adopting this means of classification it became necessary to include *Sp. celosia*, Lesson's type of the genus *Spongodes*, in the emended genus *Nephthya*; nevertheless, the name *Spongodes* was retained by Kükenthal for his other emended genus, since the latter included a large number of forms which during many years had been described under *Spongodes*. The definition of the genus *Nephthya* given in the paper under consideration runs thus:—"Nephthyiden mit 'Stützbündel.' Die Kolonie ist buschig verästelt, die meist Kurzen und nur vereinzelt sterilen Stammteile sind durch einen abgeflachten, oft membranösen Basalteil verbunden. Die Polypen stehen in grosser Zahl und ziemlich gleichmässig verteilt auf den Steinzweigen, die dadurch die Form von ährenförmigen Lappen oder 'Katzchen' erhalten. Hervorragende Spicula der Polypenköpfchen fehlen." May (1899) accepted the foregoing definition of the genus *Nephthya*, and in his 'Revision of the Nephthyidae' (1903) Kükenthal has not had occasion to modify it.

#### A "Stützbündel."

The crucial point in Kükenthal's classification of the Nephthyidae lies in the definition of the term "Stützbündel." Much of the opposition to the above classification has arisen through the different interpretations which various authors have attached to the term. Kükenthal, to whom we owe the word, uses it in an extremely comprehensive sense, the range of which can be circumscribed, however, by the following limits:—

A "Stützbündel" is an aggregation of spicules disposed along the abaxial aspect of an anthocodia and lying approximately parallel to its axis. The spicules are usually spindle-shaped; they are not infrequently larger than those from any other portion of a given specimen, and one or two of them commonly, but not invariably, reach from the apex of the polyp-stalk into the substance of the colony. A few of the spicules in a characteristic example protrude beyond the polyp-head, but such a condition is not essential.

A definite "Stützbündel" may not be recognisable in every polyp of a given colony; but if such is present it will appear most obvious in the younger polyps near the distal ends of the branches. A specimen in which a "Stützbündel" is demonstrable, whether or not in every polyp, must be classified as possessing a "Stützbündel."

In the genus *Lithophytum*, which closely resembles *Nephthya* in external appearance, the anthocodiae being massed on small terminal lobes or lappets, there is no "Stützbündel." The anthocodiae contain very few spicules, some of which are loosely arranged *en chevron* along the abaxial surface. Both the small size and oblique position of the spicules so arranged prevent their being described as forming a "Stützbündel."

*NEPHTHYA BEDFORDI*, sp. n. (Pl. LXII. fig. 8; Pl. LXIII. figs. 11, 12.)

Two specimens which, while conforming with the characters described above for the genus *Nephthya*, fail to agree in detail with any of the large number of forms hitherto described, have necessitated the creation of a new species of this genus.

The colony (fig. 8) is bilaterally compressed, the growth is bushy, and the major diameter of the capitulum is approximately equal to the total height, including the stem. The consistency is tough and leathery. The stem, which shows signs of bilateral compression, is short, and gives rise at its distal extremity to a variable number of main branches. These main branches are again divided into unequal secondary branches. From both main and secondary branches spring the short terminal lobes. The latter are conical in shape, but rounded; on them the anthocodia are tolerably evenly distributed. As the polyps are situated very close together, and the terminal lobes are exceedingly numerous, the whole capitulum appears to be covered with anthocodia. The polyp-heads when at rest make an acute angle with their stalks. The latter scarcely protrude from the colony, with the result that the polyp-heads are very closely apposed to the surface from which they arise.

Colour in alcohol cinder-grey, polyps brown.

Locality: below low-tide mark, Blakang Mati.

Detailed measurements:—

<i>Region measured.</i>	<i>Specimen I.</i>	<i>Specimen II.</i>
Total height .....	60 mm.	42 mm.
Height of stem .....	17 mm.	14 mm.
Diameter of stem .....	18 × 10 mm.	12 × 10 mm.
Height of capitulum.....	43 mm.	28 mm.
Breadth of capitulum .....	52 × 20 mm.	45 × 20 mm.

In both specimens the length of the terminal lobes is about 4 mm., but the variation in this respect is between 3 and 6 mm. The diameter of the terminal lobes is from 3 to 4 mm. The edges of adjacent polyps are seldom more than .175 mm. apart. The polyp-heads have an average length of 1.1 mm. and diameter of .6 mm.

The spicules show a wide range in size and shape. The smallest forms are found in the tentacles, where they are arranged in no very definite order, but for the most part lie at an acute angle with the axis of the tentacle. The tentacle-spicules are minute spiny spindles, some of which are straight, others crescentic. The polyp-spicules (fig. 11, *f*) are very brittle, longitudinally striated spindles. They are straight or curved, and usually smooth, but sometimes bear a few minute spines. It is difficult in most cases to discern an arrangement of the polyp-spicules *en chevron*, but some of the polyps show such a condition more clearly than others.

The "Stützbündel," though undoubtedly present, is very ill-defined. From four to six spindles can usually be observed along the abaxial surface of each anthocodia, but in no instance do these protrude beyond the polyp-head. It is exceedingly difficult to dissect out a single polyp with its supporting spicules intact; some preparations were obtained, however, after soaking portions of the branches for twelve hours or more in oil of cloves. A more satisfactory method of observing the "Stützbündel" is obtained by placing one of the terminal lobes, previously cleared in oil of cloves, under a low-power binocular microscope. By this means a stereoscopic view of the polyp and its supporting spicules is obtained, such as is represented in fig. 12. The cortex of the capitulum contains numerous horizontally disposed spindles, some of which are among the largest spicules found in this species; they resemble in type those described from the polyps. In the outer wall of the stem are found small spicules with broad rays (fig. 11, *a*) which are usually numerous, but vary considerably in size and concentration. These forms are covered with warts .015–.036 mm. long, and interlock with one another, thus accounting for the tough consistency of the stem. Among the forms described above there are also in the outer wall of the stem some larger spindles with remarkable spines (fig. 11, *b*); the latter, which have an average height of .044 mm. and basal breadth of .02 mm., are often larger and sharper on one side of the spindle than on the opposite side, and, since the spines all lie approximately in one plane, give the spicule a comb-like appearance. The spicules of the canal-walls (fig. 11, *c*, *d*) are not very plentiful, but are distinguished by their stout appearance. They may be described as very thick, longitudinally-striated spindles, somewhat flattened and bearing low rounded warts. Their ends are either rounded or bluntly pointed, the body of the spicule is straight or slightly curved. Among these regular forms there are found a few branched spicules. The latter resemble the regular forms in structure, but are either triradiate or show short irregular processes springing from the central region of a typical spindle.

The following are characteristic measurements of the spicules, length by breadth, in millimetres:—

(a) Polyp (outer) .....	.3 × .025	
(b) Polyp (inner) .....	.17 × .02	.112 × .023
	.07 × .02	
(c) "Stützbündel" .....	.75 × .05	.6 × .05
	.4 × .06	
(d) Cortex of capitulum .....	1.0 × .075	.9 × .08
(e) Cortex of stem, radiate forms .....	.115 × .181	.058 × .054
	Thickness of branches .03–.015	
Do. spindles (including spines) ...	.35 × .125	.22 × .125
(f) Canal-walls, spindles .....	1.1 × .19,	.85, .2, .6 × .11,
	.4 × .08	
Do. triradiate forms	.41 × .4,	thickness of ray .1
(measured by taking two terminal points as a base line and the third point as the extremity). .22 × .18 thickness of ray .05		

On applying the key to the species of *Nephthya* given by Kükenthal (1903, p. 145) to the case of *N. bedfordi*, it is seen that this species falls within the group characterised by forms in which the terminal lobes are conical but rounded. The inner polyp-spicules are smaller than the outer; moreover, they have the form of smooth rods. These characters taken together indicate that *N. bedfordi* resembles closely *N. pacifica* and *N. albida*; and, since the spicules do not form a ring around the base of the polyp, it may be inferred that the new species is most nearly allied to *N. albida* Holm, so far as the key to the species can be relied upon. Excepting in the character of the inner polyp-spicules, however, *N. bedfordi* appears to be more nearly related to *N. elongata* Kükenthal than to *N. albida*. This supposition is supported by the fact that *N. elongata* is reported from Ternate, while *N. albida* is a Red Sea form. The points of difference and of resemblance between *N. bedfordi* and its two nearest allies may be seen at a glance in the appended table:—

Character.	<i>N. elongata.</i>	<i>N. bedfordi.</i>	<i>N. albida.</i>
Terminal lobes { Long ...	5	6-8	9
{ Thick ...	3	4-8	7
Polyp-heads { Long .....	·8	1·1	1
{ Thick .....	·9-·6	·6	·7
Angle between Polyp and Stalk .....	45°	Acute.	Right.
Polyp-spicules { Outer ...	·27×—	·3×·025	·3×·03
{ Inner ...	·13×—	·112×·023	·4×·015
	(Spiny spindles.)	(Smooth rods.)	(Smooth rods.)
“Stützbündel” .....	Projects slightly.	Does not project.	Projects slightly.
Spicules of “Stützbündel”			
Long .....	1·5	·6	1·2
Thick ...	...	·05	·12
Spicules of Upper Cortex:			
Long .....	·8	1	1·4
Thick ...	...	·075	·12
Spicules of Lower Cortex:			
Long .....	·8	·35-·22	·85
Thick ...	(Compact.)	·125	·22
		(Comb-like and radiate forms.)	
Spicules of Canal-walls:			
Long .....	1·2	1·1-·4	1
Thick ...	(Scattered.)	·2-·08	·2
		(Spindle and tri-radiate forms.)	
Colour (in alcohol) .....	Greyish yellow.	Cinder-grey.	Greyish white.
Locality.....	Ternate, 5 fms.	Singapore.	Red Sea.

All measurements are in millimetres.

Lest the use of an artificial key to the identification of species should have led me to overlook a member of the genus not included in the group to which the Singapore specimen apparently

belongs, but at the same time exhibiting a close resemblance to it in structural detail, I have read descriptions of all the species of *Nephthya* which might possibly have proved to be identical with *N. bedfordi*. In no instance is there a greater resemblance between *N. bedfordi* and another species of *Nephthya* than exists between any two established species of that genus. Indeed, the exceedingly feeble development of the "Stützbündel" and the presence in the stem-cortex of exceptionally small, though curiously comb-shaped, spicules are characters which serve clearly to distinguish *N. bedfordi* from any species previously recorded.

Among some unpublished notes by Miss Coward, which Professor Hickson has kindly placed at my disposal, the following paragraph occurs:—

"In his work on the family Nephthyidae (1903) Kükenthal names a specimen *Nephthya chabrolii*. In doing this he refers to Hickson and Hiles' (1900) description of *N. chabrolii*. These writers, however, state that the spicules of their specimen are just as described by Klunzinger (1877)—that is to say, they do not form a 'Stützbündel.' In the description of his specimen Kükenthal says the spicules only rarely project beyond the polyp-heads—and yet his diagnosis is the presence of a 'Stützbündel.'"

This observation came to hand after the account of the new species *N. bedfordi* had been written and the "Stützbündel" described. As stated above, the "Stützbündel" was very poorly developed. I then thought it advisable to examine *N. chabrolii* to satisfy myself as to the nature of the "Stützbündel" in that species. The specimen at my disposal was the identical one described by Hickson and Hiles (1900), in Willey's collection. Preparations, which have been cleared in oil of cloves and examined under the binocular microscope, reveal the presence of distinct bundles of spindles supporting the polyps. One or two of these spicules not infrequently project beyond the polyp-heads. One must admit that *N. chabrolii* is characterised by the presence of a small but clearly defined "Stützbündel." It seemed possible that the "Stützbündel" was so degenerate in *N. bedfordi* that the polyps might be described as being without this characteristic. Were this the case, the specimen in question would come under Kükenthal's definition of the genus *Lithophyllum* Forsk. I accordingly made and examined preparations of *Lithophyllum arboreum*; but in this case there was no trace of a bundle of spicules on the abaxial surface of the anthocodiae in the least degree comparable with the condition which I have described in *N. bedfordi*.

The genus *Nephthya*, as at the present time accepted, contains a large series of species showing every gradation in the development of a "Stützbündel." At one end of the series is found such a form as *N. celosia* Lesson, in which one or two of the "Stützbündel" spicules reach 2 mm. beyond the polyp-heads; in the middle *N. chabrolii*, in which they only project slightly; and at the other end *N. bedfordi*, in which they do not project.



## Genus DENDRONEPHTHYA Kükenthal.

- 1791-97. *Alcyonium* Esper, Pflanzenthier, pp. 49, 50, tab. 16.  
 1834. Nec *Spongodes* Lesson, Illustrations de Zoologie, vol. ii. part 2, p. 89.  
 1834. *Nephthya* (pars) Ehrenberg.  
 1846. *Spoggodia* (pars) Dana, p. 625.  
 1857. *Spoggododes* (pars) Milne-Edwards, p. 127.  
 1862. *Spoggododes* (pars), *Morchellana* Gray, in Proc. Zool. Soc. London, p. 27.  
 1877. *Spongodes* (pars) Klunzinger, pp. 34, 35.  
 1889. *Spongodes* (pars) Wright & Studer.  
 1895. *Spongodes* (pars) Holm, p. 16.  
 1896. *Spongodes* (pars) Kükenthal, p. 97.  
 1899. *Spongodes* (pars) May.  
 1905. *Dendronephthya* Kükenthal, Zool. Jahrb. xxi, p. 526.

The genus *Spongodes* was founded by Lesson (1834) on the type *Sp. celosia*, and for many years workers in the field of the Nephthyidæ found no difficulty in discriminating between *Spongodes* Lesson and *Nephthya* Savigny. I have endeavoured to show in my section on the genus *Nephthya* that as the number of species of the above-mentioned genera increased it became more and more difficult to draw a hard-and-fast line between them; further, that this fact became manifest when, in 1889, Wright and Studer described a specimen as *Spongodes nephthyæformis*, which was subsequently relegated to the genus *Nephthya*, and, indeed, shown to be identical with *N. chabrolii*, the type of that genus. A new distinctive feature was required: such a feature was discovered by Holm and applied in a practical form by Kükenthal. The feature in question is the arrangement of the polyps upon the stem, and its application has already been mentioned above. Kükenthal's (1896) definition of the emended genus *Spongodes* is as follows:—"Polypenstock baumartig verzweigt, unterer Stammtteil nackt. Die Polypen sind in Bündeln vereinigt oder stehen vereinzelt." Under the genus *Spongodes* thus defined, Kükenthal included as subgenera *Spoggodia* and *Spongodes*; he further subdivided the latter into three groups, namely, Glomeratæ, Umbellatæ, and Divaricatæ. May (1899) and others adopted this classification; and so the matter stood until the year 1905, when Kükenthal published the second part of his "Revision of the Nephthyidæ." In this paper was introduced the division of the time-honoured genus *Spongodes* Less. into the two new genera, *Dendronephthya* and *Stereonephthya*, which has provoked such a storm of criticism. It must be remembered, however, that the group *Spongodes* "Spicatæ," and with it the original type *Sp. celosia*, had already been relegated to the genus *Nephthya*; so that the genus *Spongodes*, as then accepted, no longer retained its ancient prestige; moreover, since the genera *Nephthya* and *Spongodes* were shown to be synonymous, Kükenthal was justified by the International Rules of Zoological Nomenclature (Art. 28) in retaining the older name—

*Nephthya*—to designate the merged genera. The genus *Dendronephthya* is almost synonymous with *Spongodes* (Glomeratæ, Umbellatæ, and Divaricatæ), as defined by Kükenthal in 1896, and *Stereonephthya* has a like relation with his *Spongodes* (Spongodia).

There is no doubt that here, again, Kükenthal was acting in accordance with the International Rules of Nomenclature. Had these Rules been extant at the time Kükenthal published his classification of the Nephthyidæ in 1896, the name *Spongodes* would doubtless have been discarded by him then, for in the second section of Art. 30 it is written: "In no case, however, can the name of the original genus be transferred to a group containing none of the species originally included in the genus." Thus *Spongodes*, as used by Kükenthal in 1896, would not be considered as a valid generic name by those who accept the International Rules of Zoological Nomenclature, which appeared in 1905. One cannot but feel the loss of a name which for nearly a century has been familiar to students of the Alcyonaria, and regret the inconvenience caused in Museums and Zoological Laboratories throughout the world by its suppression. Nomenclature is a matter of convenience and cannot be regulated absolutely by arbitrary laws. Generally speaking, of two synonyms, that which is most familiar to the majority is to be preferred; a more practical reason should be required than a mere regulation before supplanting an old familiar generic name by a new one. If we are required to obey literally the International Rules of Zoological Nomenclature, such everyday names as *Astacus*, *Holothuria*, *Actinia*, *Madrepora*, and many others will be forfeited, as has been *Spongodes*. While regretting that Kükenthal did not exercise his authority in retaining the name *Spongodes*, in deference to his extensive knowledge of the Nephthyidæ and his able reorganisation of that family, I have adopted the term *Dendronephthya* for a genus of Nephthyidæ defined as follows by Kükenthal (1905):—

"Nephthyiden von baumförmig verzweigtem Aufbau, deren Polypen stets in Bündeln vereinigt sind, Polypen mit 'Stützbündeln.'"

*DENDRONEPHTHYA DISCIFORMIS* Kükenthal 1905. (Pl. LXIII. fig. 13.)

Three specimens in the collection agree so nearly in all essential features with the description given by Kükenthal (1905) for *D. disciformis* that there is little doubt that they may be assigned to that species. Kükenthal's specimen came from the China Sea.

The largest of the three colonies is 8 cm. high, 7 cm. broad, and 3.5 cm. thick. It was taken off Pulo Brani in 5 fms. of water.

Two other specimens were taken in 7 fms. of water between Pulo Hautu and Blakang Mati. Their measurements, height by breadth by thickness, are  $4 \times 4 \times 2.5$  cm., and  $3.5 \times 2.5 \times 1.5$  cm. respectively.

It may be noted that the two last-mentioned specimens are much smaller than any recorded by Kükenthal. The colour of the upper branches and "Stützbündel" is pink, whereas the typical colour for this region is deep red. Moreover, no radial spicules were observed in the lower portion of the stem.

The exact systematic position of a fourth specimen is rather doubtful; but, until further evidence is forthcoming, it has been deemed advisable to describe the specimen under the specific title *D. disciformis*.

This specimen shows externally the typical "*disciformis*" features. It is 9.5 cm. in height and 8.5 × 3.0 cm. in breadth, thus exceeding somewhat in dimensions the largest specimen described above. The characters and distribution of the spicules are identical with those of typical examples, only excepting those from the lower portion of the stem. The spicules found in the last-mentioned area are spiny clubs (fig. 13), among which are scattered a few of the typical radiate forms. The clubs vary in length from .70-.27 mm., but the majority are .45 mm.; the thickness is almost the same even in forms of different length, the average width of the handle of the club is .05 mm., that of the head .12 mm., excluding the spines, which sometimes reach .044 mm. in height. The colour of the branches and "Stützbündel" is a dull yellowish brown, and there are no red spicules such as are found in these areas in all the other recorded specimens. Kükenthal (1905) described a colony whose branches were pale brown and whose polyps were white, but even in this specimen red spicules were observed.

Doubtless one might be led to base a new variety of *Dendronephthya* on the characters of the colony described above, a colony possessing a very characteristic form of spicule which has not been observed, either from the same region or from any other region, in any previously recorded specimen of *D. disciformis*. Such a course might have been adopted had not this aberrant form been taken at the same time and from the same place as the two smaller of the three colonies described above, namely, between Pulo Hantu and Blakang Mati, 8/xii/98, in 7 fms. It seems probable, then, that the species *D. disciformis* is liable to considerable variation in the colour of the terminal branches and "Stützbündel," and in the character of the spicules which are found in the lower region of the stem. The latter phenomenon is very remarkable, and, it is hoped, may act as a check to the frequency with which new species are created to separate two or more specimens of *Aleyonaria* which only differ from one another in the shape of their spicules.

#### Genus STERONEPHTHYA Kükenthal.

- 1869. *Spoggodia* (pars) Gray, in Ann. & Mag. Nat. Hist. (4) vol. iii. p. 128.
- 1877. *Spoggodia* (pars) Klunzinger.
- 1889. "Divaricate" (*Spongodes*) Wright & Studer.



The polyps arise sporadically from all parts of the colony. They are closely aggregated on the lateral lobes, and are most scarce on the basal portion of the primary lobes. The anthocodiae are supported by a "Stützbündel" (fig. 14), three horny spindles of which project 2-4 mm. beyond the polyp-head. The polyp-heads make an acute angle with their stalks; the stalk is 1.2 mm. high, the head is 1 mm. in length and  $7.85$  mm. in maximum breadth. The polyps contain thorny spindles of various sizes and a few clubs. These are sometimes placed horizontally, but are more usually oblique, and in the distal area are arranged *en chevron*. These spindles measure  $45 \times .035$ ,  $27 \times .04$ ,  $2 \times .025$  mm. Among the above and extending into the tentacles are numerous little spicules which are nearly rectangular in outline; they measure  $110 \times .036$ ,  $95 \times .015$ ,  $50 \times .015$  mm. The "Stützbündel" is composed of a number of thorny spindles of a bright yellow colour (they resemble at first sight crystals of sulphur). These spicules are ten in number round the base of the polyp-stalk, but there are only three at the distal end. The four spicules which underlie the point of origin of the polyp-head are semi-lunar in shape, the concave sides facing the polyp-head. The "Stützbündel" spicules reach 1.8 mm. in length and 12 mm. in breadth. The cortex of the colony derives its characteristic colour from the enormous number of slim yellow spicules which it harbours. There are also thorny spindles; they lie parallel to and very near the surface, and vary very much in size and shape. Some are twice, others only half, the size of the "Stützbündel" spicules. Few are straight, most are semi-lunar or S-shaped, and very exceptionally a triradiate form occurs. The ends of the spindles are usually bluntly pointed, but occasionally forms were observed with their ends frayed out into a number of points. The largest measure  $3.0 \times .28$ ,  $2.7 \times .30$ ,  $2.1 \times .15$ , the smallest  $.67 \times .07$ ,  $.67 \times .04$ ,  $.55 \times .05$  mm., but every conceivable intermediate stage can be found. A remarkable feature of this species is the entire absence of spicules from the caudal-walls.

The colour of the colony in alcohol is pale yellow, the polyps are cream-coloured.

The specimen was taken in Imbiab Bay, where it was left exposed at the lowest tides.

Two other specimens taken in the littoral region at Teluk Ayer have also been assigned to this species. At first sight they do not resemble closely the type specimen, for they are shorter, broader in proportion, and more bushy in appearance than the colony described above. One of these colonies is 4.3 cm. in height, its base is .8 cm., and the maximum diameter of the capitulum is 3.1 cm.; the measurements of the other, taken in the above order, are  $3 \times 7$  cm.: 4.5 cm. The apparent difference in the branching from that of the type is due to the fact that the secondary branches are no larger than the lateral lobes, and that both these kinds of offshoot are relatively numerous. The polyps are arranged much more densely than in the type,

especially at the tips of the branches. The colour of these specimens, moreover, is of a duller yellow. These slight differences appear quite insignificant when one considers that these two specimens resemble the type of *Stereonephthya lutea* in the following important characters:—

The size and shape of the anthocodiae. The size, distribution, and remarkable sulphur-yellow colour of the spicules; the distribution of spicules agrees even to the disposition of those forming the "Stützbiindel"; the large internal canals, with thin walls devoid of spicules.

#### Genus PARASPONGODES Kükenthal,

P. CRASSA Kükenthal, 1896.

This species was first described by Kükenthal in 1896, and further reference to it is made by the same author in his 'Revision der Alcyonarien' (1907), where it is described under "Species incerti generis." Two small colonies of a pale brown colour are placed without hesitation in this species.

One colony was taken in 5-9 fms. of water from the New Harbour. It measures 20 mm. in height; the diameter of the capitulum is 13 mm., that of the stem 7.5 mm.

The other colony was taken in 5 fms. of water, the precise locality is not recorded. It measures 20 mm. in height; the diameter of the capitulum is 11 mm., and the stem is broken.

The only important character in which these specimens differ from the type is the size of the spicules in the stem-cortex. Measurements, length by breadth in millimetres, for three of the largest spicules from this region are  $1.2 \times .18$ ,  $1.0 \times .15$ ,  $.95 \times .22$ . Kükenthal found spicules measuring as much as  $1.8 \times .24$  mm. in the stem-cortex. The spicules from the Singapore specimens show, however, the typical warts (.02 mm. high).

Previously recorded from Ternate, at a depth of 30 fms.

#### Family SIPHONOGORGIIDÆ.

##### Genus SIPHONOGORGIA.

S. VARIABILIS Hickson (olim *Chironcephthya variabilis* Hickson).

Two beautiful little specimens taken in 10 fms. of water south of Blakang Mati are referred to this very variable species. Each possesses a very slender stem, from the apex of which two main branches are given off, so that the appearance of the colony is roughly Y-shaped. These primary branches give rise to secondary branches, which in one or two cases are again divided. The polyps occur most frequently on the tips of the branches, but a few are scattered on all portions of the colony except the stem.

Measurements:—

	Specimen A.	Specimen B.
	mm.	mm.
Height of stem.....	18	11
Diameter of stem.....	6	3
Length of primary branches .....	23 and 23	24 and 18
		35*

The spicules are of the usual shape and of medium size, and assume the colour of the part of the colony in which they are embedded. The large warty spindles of the coenenchym are tinted with mauve and do not exceed  $3.0 \times .3$  mm. In the polyp-area the spindles are more frequent than the clubs; all the polyp-spicules are more or less bent, they are either bright red or bright yellow in colour, and the larger ones measure  $.6 \times .05$  mm.,  $.47 \times .065$  mm. (the red spicules mainly compose the "crown," the yellow ones the "points").

The colour of the colony in alcohol is a delicate pinkish mauve. The polyps are deep red, and the tentacles bright yellow. It is difficult to conceive how the colouring could have been more vivid or the blended tints more pleasing even before these little colonies were removed from their natural habitat.

For a list of the colour-variations to which this species is liable to run, see Hickson's "Aleyonaria of the Maldives," Part I. p. 488 (under *Chironophthya variabilis*), and Thomson and Simpson (1909, p. 125).

Previously recorded from Mahlos Atoll, S. Nilandu, Persian Gulf, Andamans, and the Arakan Coast.

## Order GORGONACEA.

### Suborder PSEUDAXONIA.

#### Family SCLEROGORGIIDÆ.

##### Genus SUBEROGORGIA.

##### *S. SUBEROSA* Pallas.

*Gorgonia suberosa* Pallas, Elench. Zooph. p. 191.

*Suberogorgia suberosa* Gray, Proc. Zool. Soc. 1857, p. 159.

*Sclerogorgia suberosa* Kölliker, Icon. Histiol. p. 142, pl. xix. fig. 13 (2).

*Sclerogorgia suberosa* Studer, Monatsber. K. Akad. Wiss. Berlin, 1878, p. 666.

*Suberogorgia suberosa* Ridley, Journal Linn. Soc. Zoology, vol. xxi. p. 243.

*Suberogorgia suberosa* Wright & Studer, 'Challenger' Reports, vol. xxxi. p. 166.

*Suberogorgia suberosa* Brundin, "Aleyonarien aus dem Sammlung der Zool. Mus. in Upsala," Svenska Vet.-Akad. Handl. xxii. pt. iv.

There is in the collection a bottle which contains a number of fragments, apparently the component parts of a single colony of *S. suberosa*. The basal portion is present and has a diameter of 6 mm.; the diameter of the terminal branches is 2.5 mm. The specimen was taken in about 14 fms. of water off Pasir Panjang.

Previously recorded from the coasts of Western Africa and the West Indies (Pallas and Esper); the Mermaid Straits, Dampier Archipelago, and N.W. Coast of Australia (Studer); Port Denison, Queensland, and Torres Straits ('Alert' Coll.); Mauritius (Coll. Brit. Mus.); Admiralty Islands ('Challenger' Coll.); and Sumatra (Brundin).

### Family MELITODIDÆ.

#### Genus MELITODES.

##### M. ALBITINCTA Ridley.

This species is represented by numerous fragments, but none of these represents an entire colony. The specimens were taken in 15 fms. of water from Blakang Mati.

Previously recorded from Port Molle, Queensland.

#### Genus PSILACABARIA.

##### P. GRACILLIMA Ridley.

*Psilacabaria gracillima*, n. gen. et sp., Ridley, Rep. Zool. Coll. H.M.S. 'Alert,' Alcyonaria, p. 363.

After a lapse of nearly three decades this delicate little species is to be recorded once more. It is represented in the collection by four portions of colonies, which show the mode of branching and length of the internodes, and by sundry fragments. None of the colonies are complete, but the largest intact portion measures 45 mm. in height. The internodes vary in length, the majority, however, fall within the range given by Ridley, viz. 12-16 mm. The branches are much more delicate than those of the type, measuring only 1-2 mm. in diameter, as compared with 3-7 mm. In the mode of branching, size of polyps, and details of spicule-distribution the Singapore specimens resemble the type very closely. The spicules show the typical shapes; but they are in each instance somewhat smaller than their prototypes. The colour of the cœnosarc and polyps is fawn, that of the axis white.

*Locality.* Salát Sinki, in 4-5 fms.

Previously recorded from Port Molle, Queensland, 12-20 fms.; Port Darwin, 8-12 fms.; E. Australia, 42 fms. (Ridley).

#### Genus WRIGHTELLA.

##### W. ROBUSTA, sp. n. (Pl. LXII. fig. 9; Pl. LXIII. fig. 15.)

This species has been formed to include a single well-developed colony, which agrees more closely with *Wrightella* Gray (1870) than with any of the other genera of the family Melitodidæ. The form of the colony differs, in its stouter dimensions and in its erect position, from the members of the four existing species of *Wrightella*; but it was thought expedient to associate it with



these, rather than to create a new genus from the observation of a single specimen.

Wright and Studer (1889, p. xxxvi) give the following definition of the genus *Wrightella*:—"The branches and twigs are compressed; the projecting polyp calyces occur especially on the sides. In the cortex there are foliaceous clubs. There are no nutritive canals in the axis." The specimen fulfils all these conditions.

The single main stem arises abruptly from a strong reticulate base (fig. 9). The base, which is broken at the edges, measures 15 mm. in diameter, and the gaps in its meshes average 1 mm. in diameter. The colony is 120 mm. in height and 45 mm. in breadth (some of the lateral branches are broken, so it is probable that the true breadth exceeded 45 mm.). The branching of the colony is dichotomous, and takes place at the swollen nodes. The nodes are less prominent in the distal branches. All the branching takes place in one plane; the terminal twigs are markedly flattened in the plane of branching. Anastomosis of the upper branches takes place at infrequent intervals. The nodes near the base are globular, having a diameter of 4 mm.; the internodes in this region are circular in section, their diameter is 2.5 mm., which is slightly exceeded by their length. The internodes beyond the lowest three become more elongated and show an average length of 10 mm. The terminal twigs are only 1 mm. wide. The verrucae, which measure  $.75 \times .75$  mm., are not densely crowded, and show a tendency to arrange themselves on the lateral aspects even of many of the lower branches, but more especially in the terminal twigs. Both cortex and verrucae are yellow in colour. The axis is white, and is not traversed by nutrient canals.

The precise locality is not recorded, but, like the other specimens in this collection, it was taken in shallow water near Singapore.

The spicules attain all manner of shapes (fig. 15); they are quite colourless. The foliaceous clubs characteristic of the genus *Wrightella* are present in large numbers, and show the following range in measurement: length by breadth  $.27 \times .12$  mm.,  $.15 \times .06$  mm.; handles of clubs  $.02$  mm. in diameter. Numerous spindles occur, some are foliaceous and measure  $.27 \times .07$  mm.,  $.20 \times .08$  mm.,  $.12 \times .06$  mm.; others are spiny, the spines frequently being confined to the central region, and measure  $.22 \times .05$  mm.,  $.17 \times .03$  mm.,  $.12 \times .03$  mm. A few stellate forms are found which have a diameter of  $.10$ – $.15$  mm. Minute scales abound; they measure  $.05 \times .025$ ,  $.036 \times .030$  mm.,  $.028 \times .014$  mm.

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## EXPLANATION OF THE PLATES.

## PLATE LXI.

- \*Fig. 1. *Ammothea virescens* Sav. (= *Lithophytum arboreum* Forsk.), entire colony; Savigny, Tab. 2. fig. 1. 1.
- \*Fig. 2. *Nephthya chabrolii* Audouin, terminal lobe magnified; Savigny, Tab. 2. fig. 5. 2.
- \*Fig. 3. *N. chabrolii*, single polyp magnified, lateral aspect; Savigny, Tab. 2. fig. 5. 3.
- \*Fig. 4. Same, abaxial axis; Savigny, Tab. 2. fig. 5. 4.
- \*Fig. 5. Same, more highly magnified; Savigny, Tab. 2. fig. 5. 5.

## PLATE LXII.

- \*Fig. 6. *N. chabrolii*, entire colony; Savigny, Tab. 2. fig. 5. 1.
- Fig. 7. *Sclerophytum pinnulatum*, sp. n., entire colony; from a photograph, slightly reduced.
- Fig. 8. *Nephthya bedfordi*, sp. n., entire colony; from a photograph, natural size.
- Fig. 9. *Wrightella robusta*, sp. n., entire colony; from a photograph,  $\times \frac{1}{2}$ .

## PLATE LXIII.

- Fig. 10. *Sclerophytum pinnulatum*, sp. n., tentacle bearing pinnules,  $\times 245$ .
- Fig. 11. *Nephthya bedfordi*, sp. n., spicules,  $\times 72$ .
- Fig. 12. *N. bedfordi*, terminal lobe bearing polyps,  $\times 25$ .
- Fig. 13. *Dendronephthya disciformis* Kükth. (aberrant specimen), spicules from the stem-cortex,  $\times 72$ .
- Fig. 14. *Stereonephthya lutea*, sp. n., polyp and “Stützbündel,”  $\times 72$ .
- Fig. 15. *Wrightella robusta*, sp. n., stem-spicules,  $\times 72$ .

\* Figures marked thus are reproduced from photographs procured by Professor Bourne, and kindly given by him to me for the purpose.

27. Some early Fossil Cirripedes of the Genus *Scalpellum*.

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(Text-figs. 64 &amp; 65.)

## INDEX.

	Page
Structure of carina of <i>Scalpellum</i> .....	528
Evolution of early fossil forms of <i>Scalpellum</i> .....	530
Distribution (Geological) of Cretaceous <i>Scalpellum</i> .....	537
<i>Scalpellum arcuatum</i> Darwin .....	532
<i>S. trilineatum</i> Darwin .....	531
<i>Scalpellum</i> spp.—discussion of affinities .....	538

Among the Cirripede remains from the Albian (Gault) of Folkestone in the collection of the British Museum (Natural History), three detached valves were noticed, which, for certain reasons to be explained later (see p. 532), appear to be the original valves upon which Darwin founded the species *Scalpellum arcuatum* †. A portion of one of the valves, a carina ‡, happened to be broken away from its matrix, showing that the intraparietes, said by Darwin to be absent in this species, were really present. These parts, however, are developed in such a way that they can be seen only by cleaning the valve free from matrix. The finding of the intraparietes in Darwin's type of *S. arcuatum* led to the examination of further examples of the carina, and the fact was established that intraparietes are developed in all carinæ of this species.

*S. trilineatum* Darwin (1851, p. 38, pl. i. fig. 5), from the Cenomanian (Grey Chalk) of Dover, was said by Darwin to come nearest to *S. arcuatum*, owing to the absence of intraparietes. The carina, which is the holotype of *S. trilineatum*, is in the British Museum (Natural History), registered 38461. On freeing this specimen from the gum and matrix which obscured the inner portion of the valve, it was at once apparent that not only were the intraparietes present, but that they were developed almost exactly as in *S. arcuatum*.

Other Lower Cretaceous species of *Scalpellum* in which the intraparietes of the carina are said to be absent are *S. simplex* Darwin (1851, p. 39, pl. i. fig. 9) and *S. accumulatum* Withers §, both of which come from the Aptian (Lower Greensand). The unique carina of *S. simplex* cannot at present be traced, but since the parietes do not reach to the basal margin of the valve (see text-fig. 64, 1) as in those carinæ which have intraparietes, it does not appear probable that intraparietes could be present. In

\* Communicated by Dr. W. T. CALMAN, F.Z.S.

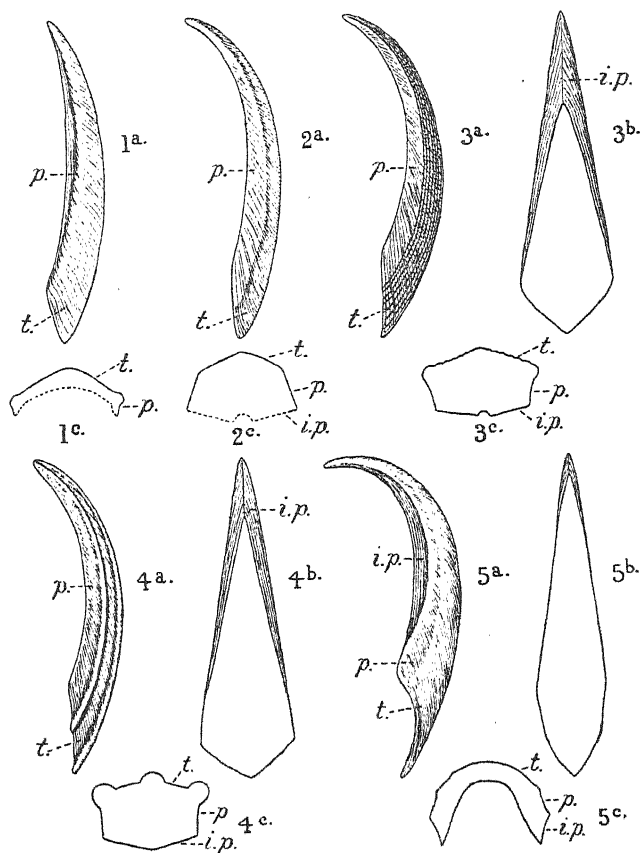
† C. R. Darwin, 1851, Pal. Soc. Monogr. Foss. Lepididæ, p. 40, pl. i. fig. 7.

‡ For the names of the various valves see text-fig. 65.

§ T. H. Withers, 1910, Geol. Mag. dec. v. vol. vii. p. 152, figs. 1-4.

*S. arcuatum* (text-fig. 64, 3) and *S. trilineatum* (text-fig. 64, 4) the parietes reach to the basal margin, and in my opinion the intraparietes will be found to be developed in *S. accumulatum* (text-fig. 64, 2) as in those species, since *S. accumulatum* is similar in its general external form. The only carina known

Text-fig. 64.

Early types of the Carina of *Scalpellum*.

1 a-5 a, side view; 3 b, 4 b, 5 b, inner view; 1 c-5 c, transverse section near apex.  
t., tectum; p., parietes; i.p., intraparietes.

of *S. accumulatum* is embedded in such a hard matrix that it is impossible to expose its inner surface without danger to the specimen, so that the matter must here remain until further specimens are forthcoming.

So far, then, we have proved the existence of intraparietes in

the carinae of the two species *S. arcuatum* and *S. trilineatum*, and pointed out the possibility of their presence in *S. accumulatum*. The intraparietes in these species, instead of forming a thin wall on each side of the carina as in the form represented by text-fig. 64, 5, are bent inwards almost at right angles, and the upper regions of their inner margins meet to a greater or less extent (see text-fig. 64, 3b, 4b); the upper part of the valve is solid, and must have projected freely to the extent indicated by the meeting of the intraparietes\*. The peculiar development of the intraparietes in the carinae of these species is therefore of importance as showing a development of the carina distinct from that in which the intraparietes form a thin wall on each side of the carina.

Three types of carina, all having an apical umbo, were therefore already developed amongst these early forms of *Scalpellum*, and the geologically oldest of these more closely resemble the carina of *Pollicipes*, from which *Scalpellum* is considered to be derived. These are (1) represented by *S. simplex* (text-fig. 64, 1) from the Aptian (Lower Greensand), which has no intraparietes, the tectum being flatly-arched transversely, the parietes bent almost at right angles to the tectum and not extending to the basal margin; this type is distinguished from the *Pollicipes* type of carina only in the parietes being separated from the tectum by a distinct angle; (2) represented by *S. accumulatum* (text-fig. 64, 2) (Aptian, Lower Greensand), *S. arcuatum* (text-fig. 64, 3) (Albian, Gault), and *S. trilineatum* (text-fig. 64, 4) (Cenomanian, Grey Chalk), which have intraparietes, these parts being bent inwards almost at right angles and joining, the upper part of the valve being solid and projecting freely to a considerable extent; in the solidity and free projection of the upper part of the valve this type is allied to *Pollicipes*; (3) represented by *S. hastatum* (text-fig. 64, 5) and other species from the Cenomanian which have intraparietes also, but are characterized by these parts forming a thin wall on each side of the carina, the apex of which projects freely, slightly, or not at all; this latter type is more typical of the genus *Scalpellum*, and, owing to the upward growth of the intraparietes in some forms, subsequently gave rise to the species with an angularly bent carina having the umbo in a subcentral position, a type which is not known below the Upper Senonian. The only species with an angularly bent carina known from the English Chalk is *S. darwinianum* Bosquet†, but this has an early specialized form of carina in which the upward

\* A somewhat similar development of the intraparietes can be seen in the carina of *S. maximum* var. *cylindraceum* Darwin (1851, p. 33, pl. ii. fig. 2) from the Upper Senonian (*Belemnitella mucronata*-zone) of Norwich, Norfolk, and *S. solidulum* Steenstrup (1839, Krøyer, Naturhist. Tidsskrift, Bd. ii. p. 412, pl. v. figs. 14, 14\*; Darwin, 1851, Pal. Soc. Monogr. Foss. Lepadidae, p. 42, pl. i. fig. 8) from the Upper Senonian of Kjøge, Scania.

† J. Bosquet, 1854, Les Crust. Foss. du Terrain Crétacé du Duché de Limbourg, p. 46, pl. iv. figs. 6-12; T. H. Withers, Jan. 1911, Geol. Mag. dec. v. vol. viii. p. 23, figs. 3-4.

extension of the valve is due, not merely to the upward growth of the intraparietes, but to the almost equal upward and downward growth of the valve from the umbo, the whole external surface of the valve being ornamented. It is, therefore, probable that species with an angularly bent carina, due to the upward growth of the intraparietes, which is apparently the more primitive type, existed even earlier than in the Upper Senonian\*.

Extreme interest attaches to the remarkably complete example of *S. arcuatum* from the Albion (Gault) of Folkestone, Kent, here described and figured (p. 534, text-fig. 65, 6). To find so many valves of the capitulum in position is a remarkable circumstance, very few specimens of *Scalpellum* having been discovered with several valves associated. Those known up to the present come from the Upper Senonian, and, with the exception of a single incomplete capitulum of *S. maximum*, belong to the species *S. fossula*. This specimen, therefore, represents the only fossil species of *Scalpellum* obtained from below the Upper Senonian with any considerable number of valves in position. Previously described species of *Scalpellum* from rocks below the Upper Senonian have all been founded on detached valves, and in most cases on single valves. Neither the upper latus, rostral latus, or rostrum, are included in these descriptions, but are represented in the present specimen. A further example of *S. arcuatum* (described, p. 533) has furnished some scales of the peduncle, which so far are not known in any species found below the Upper Senonian. *S. arcuatum* is the only representative of *Scalpellum* known from the Albion (Gault) of England.

Consequent on the discovery of the intraparietes in the carinæ of *S. arcuatum* and *S. trilineatum*, and since the carina is the typical valve of the genus, it is here proposed to give fresh diagnoses of those species and to describe the new material of *S. arcuatum*. From the two examples of *S. arcuatum* it is possible to construct a restoration of the capitulum, to which only two valves are diagrammatically added (see text-fig. 65, 7, p. 534).

#### SCALPELLUM TRILINEATUM Darwin.

1851. *Scalpellum trilineatum* C. R. Darwin, Pal. Soc. Monogr.  
Foss. Lepadidæ, p. 38, pl. i. fig. 5.  
1854. *Scalpellum trilineatum* C. R. Darwin, Ray Soc. Monogr.  
Sub-class Cirripedia, Balanidæ, Synopsis et Index  
Systematicus, p. 633.  
1854. *Scalpellum trilineatum* J. Morris, Cat. British Fossils,  
2nd ed., p. 97.  
1877. *Scalpellum trilineatum* H. Woodward, Brit. Mus. Cat.  
Brit. Foss. Crustacea, p. 143.

\* Since the above was written, two exceedingly small, angularly bent carinæ (length respectively 1·7 mm. and 1·8 mm.) with the umbo subcentral, due to the upward growth of the intraparietes, have been obtained by Mr. F. Möckler from the Cenomanian (Chalk Marl) near Cambridge. The specimens are incomplete and poorly characterized, but of much importance as showing that species with an angularly bent carina existed even so far back in time as the Cenomanian.

This species was founded on a carina and tergum from the Cenomanian (Grey Chalk) of Dover. The tergum cannot now be found, but the carina, which Darwin considered to be the typical valve of the genus and can therefore be regarded as the holotype, is in the British Museum (Natural History) registered 38461.

*Diagnosis.*—Carina with three prominent, rounded, longitudinal ridges on its tectum—one central, and one on each side separating the tectum from the parietes; intraparietes bent inwards almost at right angles, the inner margins meeting a short distance below the apex, upper part of valve solid and projecting freely.

*Description of Carina.*—Carina narrow, widening very gradually from the apex, considerably bowed inwards, basal margin obtusely angular. Tectum flatly-arched transversely, with a central, prominent, rounded ridge extending from the apex to the basal margin, and bounded on each side by a slightly coarser but flatter ridge on the angle separating the tectum from the parietes. Parietes narrow, less than half the width of the tectum, bent almost at right angles to the tectum, slightly concave. Intraparietes very narrow, bent inwards almost at right angles, the inner margins meeting about one-sixth the length of the valve from the apex; the upper part of the valve is solid, and must have projected freely to the extent indicated by the meeting of the intraparietes. Lines of growth plainly marked.

SCALPELLUM ARCUATUM Darwin. (Text-fig. 65.)

1851. *Scalpellum arcuatum* C. R. Darwin, Pal. Soc. Monogr. Foss. Lepadidæ, p. 40, pl. i. fig. 7.  
 1854. *Scalpellum arcuatum* C. R. Darwin, Ray Soc. Monogr. Sub-class Cirripedia, Balanidæ, Synopsis et Index Systematicus, p. 633.  
 1854. *Scalpellum arcuatum* J. Morris, Cat. British Fossils, 2nd ed. p. 96.  
 1865. *Scalpellum arcuatum* J. W. Salter & H. Woodward Cat. & Chart Foss. Crustacea, p. 27, pl. i. fig. 14.  
 1877. *Scalpellum arcuatum* H. Woodward, Brit. Mus. Cat. Brit. Foss. Crustacea, p. 142.

The species *S. arcuatum* was founded on three detached valves, namely, carina, scutum, and tergum, from the Gault of Folkestone, Kent. These valves were considered by Darwin to belong to the same species, and the material now to be described proves such to be the case. Darwin further stated that these valves were in the Bowerbank Collection. This collection was acquired in 1865 by the British Museum (Natural History), and among the specimens are three valves, a carina (I. 13796), a scutum (I. 13797), and tergum (I. 13798), mounted together on Bowerbank's original tablet, and labelled in Darwin's handwriting "*S. arcuatum*." The carina has been much broken, presumably since Darwin described it, but the scutum and tergum are in good

condition. These specimens are also exactly half the size of Darwin's figures, which are enlarged to two diameters, and in these circumstances there seems little doubt that they are the original valves figured by Darwin. The carina, since Darwin considered it to be the typical valve of *Scalpellum*, is consequently regarded as the holotype.

Two specimens in the British Museum (Natural History) add considerably to our knowledge of this species.

One, registered (I. 13577), text-fig. 65, 6, first appeared to consist of a carina with fragments of the scuta and terga. Careful clearing away of the matrix and the abundance of gum which covered the specimen showed, however, that several of the valves of the capitulum were preserved. These consist of the carina, the paired scuta, the paired terga, an upper latus, a rostral latus, and the rostrum. The left side of the capitulum is uppermost, and the carina is so exposed that the intraparietes can readily be seen. Portions of the inner surfaces of the right scutum and tergum are also exposed owing to the fact that the upper valves are somewhat displaced and broken.

The second specimen (I. 13580) has not so many valves preserved and those present are somewhat broken. The right side is uppermost, and the plates shown are the carina, the pair of terga, the upper portion of the left scutum showing its inner surface, and the left upper latus. This last valve showed only its inner surface, but on removal from the matrix it was found to be the left upper latus. This specimen is of interest since it furnished eighteen scales of the peduncle. A supposed shell-fragment was removed from between the two terga, and on being cleaned was found to be a peduncle scale. On removing and washing the remaining matrix from the same position, the number of scales was increased to eighteen. There is little doubt that these scales belong to *S. arcuatum*, since it is the only species of *Scalpellum* known to occur in the Gault. Moreover, they are ridged like the valves of the capitulum of that species, and the fact that they were found in such close association is *prima facie* evidence that they belonged to the same individual, and were washed into the position in which they were found. They are somewhat similar in shape to the scales of the peduncle of the Upper Senonian species *S. maximum* and *S. fossula* as figured by Th. Marsson\*, but are easily distinguishable from them by their longitudinal ridging.

*Diagnosis.*—Capitulum composed probably of fourteen valves†, which are ornamented with numerous fine ridges radiating from their apices; umbo of all valves apical. Carina with tectum flatly arched transversely, parietes rectangulantly inflected,

\* Th. Marsson, 1880, "Die Cirripeden und Ostracoden der weissen Schreibkreide der Insel Rügen," Mitth. naturwiss. Vereine Neu-Vorpommern und Rügen, xii. pl. i. figs. 2 b, c, d, 3 d, e.

† It is possible that this species had a subcarina, in which case the number of valves would be fifteen. A higher number of valves is not likely.



Text-fig. 65.

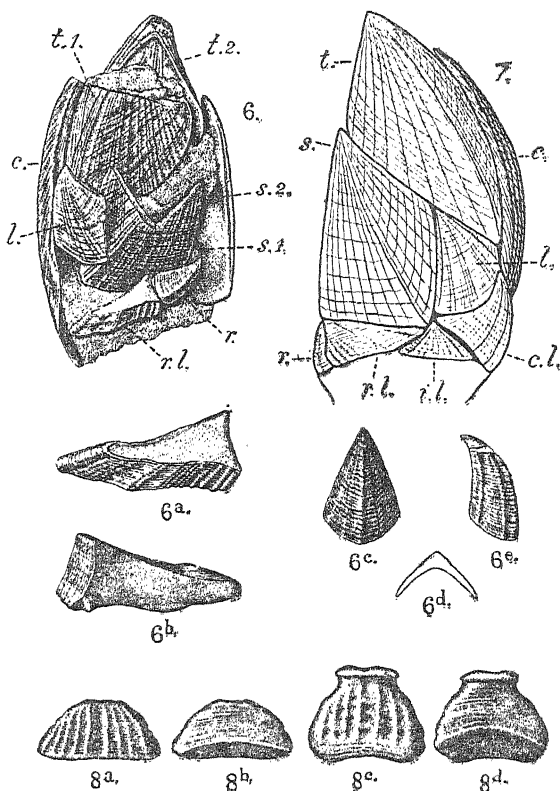


Fig. 6. *Scalpellum arcuatum* Darwin. Nearly complete capitulum showing the left side uppermost, with the valves somewhat displaced and broken.  $\times 2$  diam. Albian, Gault; Folkestone, Kent. Brit. Mus. (Nat. Hist.), I, 13577. c., carina, showing the inflected intraparietes; t.1, outer portion of left tergum; t.2, inner view of right tergum near apex, showing the ridges evidently connected with the firm attachment of the corium; s.1, outer portion of left scutum; s.2, inner view of right scutum showing the pit for the adductor scutorum; l., upper latus; r.l., rostral latus with upper portion broken off; r., rostrum.

Fig. 6 a. Id. Outer view of incomplete rostral latus.

Fig. 6 b. Id. Inner view of same.

Fig. 6 c. Id. Outer view of rostrum.

Fig. 6 d. Id. Hypothetical transverse section of same.

Fig. 6 e. Id. Side view of same.

$\times 4$  diam.

Fig. 7. Restored capitulum of *Scalpellum arcuatum* Darwin. This figure is based on the nearly complete capitulum represented by fig. 6, with the addition of a carinal latus and an infra-median latus. These two valves have not yet been discovered in the Gault.  $\times 2$  diam. Albian, Gault; Folkestone, Kent. c.l., carinal latus; i.l., infra-median latus.

Fig. 8. *Scalpellum arcuatum* Darwin. Two scales of the peduncle, a, outer view, b, inner view; c, outer view; d, inner view.  $\times 8$  diam. Albian, Gault; Folkestone, Kent. Brit. Mus. (Nat. Hist.), I, 13580.

intraparietes bent inwards and meeting for about one-fourth the length of the valve from the apex, upper part of valve solid and freely projecting. Scutum with tergo-lateral angle almost in line with the middle of the valve. Tergum subrhomboidal, a delicate furrow extending from the apex to the basal angle. Upper latus subtriangular, apex acutely angular, slightly bowed towards scuta, basal margin rounded. Rostral latus acutely angular transversely, about  $2\frac{1}{2}$  times as long as wide. Rostrum subtriangular, with a strong median keel extending from the apex, widening towards the convex basal margin.

*Description of valves.*—Carina narrow, widening gradually from the apex, considerably bowed inwards, basal margin obtusely V-shaped. Tectum flatly-arched transversely, obscurely carinate, and ornamented with numerous fine longitudinal ridges. Parietes narrow, less than half the width of tectum, not longitudinally ridged, bent almost at right angles to the tectum, slightly concave. Intraparietes very narrow, bent inwards almost at right angles, the inner margins meeting about one-fourth the length of the valve from the apex, above which the valve is solid and must have projected freely.

Scutum moderately convex, divided unequally by a prominent ridge running from the apex to the basi-lateral angle, the basi-lateral angle being slightly produced. Apex acuminate. Basal margin sinuous, about two-thirds the length of the valve; ocludent margin slightly convex and nearly parallel to the lateral margin; tergal and lateral margins of almost equal length and forming an angle of about  $145^\circ$ , either margin being about half the length of the valve. Surface of valve ornamented with fine, closely-set, longitudinal ridges; a narrow slip along the tergal margin is somewhat bent downwards and is devoid of ridges.

Tergum sub-rhomboidal in general outline, slightly convex, with a delicate furrow extending from the apex to the basal angle. Apex and basal angle acuminate, more so than is indicated in Darwin's original figure; scutal angle somewhat protuberant, Carinal margin convex; scutal margin sinuous, longer than the ocludent margin, which is nearly straight. Surface of valve ornamented with numerous fine longitudinal ridges. Inner surface, in the region of the apex, is marked on its edges with oblique lines of growth, these indicating the extent to which the valve projected freely. A little below the apex, nearer to the ocludent margin, are three or four small ridges ending abruptly about one-fourth the length of the valve from the apex. These ridges were evidently connected with the firm attachment of the corium, or membrane which lined the inner surfaces of the valves, and are homologous with the series of tubercles on the inner surfaces of the terga of *S. darwinianum* Bosquet.

Upper latus subtriangular, slightly curved towards the scuta, almost flat transversely, convex longitudinally; umbo slightly projecting, with a thick ledge formed beneath it, which thins out towards the lateral angles; tergal margin slightly convex; scutal

margin slightly concave and about the same length as the tergal margin, the two margins if represented by lines from the apex to the lateral angles would enclose an angle of about  $55^{\circ}$ ; basal margin rounded, and indistinctly marked off into three lines; a portion of the valve on either side, parallel with the scutal and tergal margins, is somewhat raised, and the lines of growth on these parts are upturned sharply towards the umbo. Surface of valve between the raised portions ornamented with several longitudinal ridges.

Rostral latus.—This valve is imperfect, the upper portion being broken off. Valve very narrow, acutely angular transversely, about  $2\frac{1}{2}$  times as long as wide, widening gradually from the inner acute extremity to the rostral margin, which is abruptly truncate; umbo apical; the inner extremity is marked by a strong rounded keel; outer (rostral) half of valve ornamented with fine longitudinal ridges, two fine ridges close together almost dividing the basal margin into two equal portions. At the point where these two ridges reach the basal margin the valve is somewhat convex, no doubt indicating the extent to which the valve was bounded by the inframedian latus.

Rostrum sub-triangular, strongly convex transversely, bowed inwards; lateral margins bounded by strong ridges; basal margin convex; a strong median rounded keel extends from the apex, widens considerably towards the basal margin, and is bounded on either side by indistinct longitudinal ridges.

Peduncle scales varying in shape from semilunar to trapezoidal, the basal margin of the former being straight, while that of the latter is somewhat concave: immediately below the apex the trapezoidal scales are slightly constricted, the truncated top appearing to overhang; scales thickest at one-third from the base, below which, on the inner surface, they are somewhat excavated, this indicating the extent to which the scales were covered by the corium, the upper two-thirds no doubt overlapping the contiguous scales. Outer surface ornamented similarly to the valves of the capitulum with a number of longitudinal ridges. These ridges number about seven on the larger scales, and four or five on the smaller scales.

*Measurements.*—Owing to the fact that the valves in these two specimens of *S. arcuatum* are broken, it is impossible to give their accurate measurements. Since, however, it is desirable that we should have some idea of the relative sizes of the valves in an individual, approximate measurements are given where the correct measurements cannot be obtained.

Specimen I. 13577.

Carina. Length circa 21 mm.

Scutum (right valve). Length (from apex to rostral angle) 13.5 mm.; breadth 7.4 mm.

Tergum. Length circa 17 mm.; breadth 8.2 mm.

Upper latus. Length 6·8 mm.; breadth circa 7·5 mm.

Rostral latus. Length 6·3 mm.; breadth 2·6 mm.

Rostrum. Length 3·4 mm.; breadth 2·2 mm.

Specimen I. 13580.

Carina. Length circa 20 mm.

Tergum. Length circa 17 mm.; breadth 7·5 mm.

Upper latus. Length 5·9 mm.; breadth circa 4·2 mm.

Scales of peduncle. Length from 0·5 mm. to 1·2 mm.; breadth 1·3 mm. to 2 mm.

*Remarks, and comparison with other Species.*—The restoration of *S. arcuatum* (text-fig. 65, 7) is based on the nearly complete capitulum figured on the same page, and, to complete the capitulum, a carinal latus and an inframedian latus have been added. The carinal latus figured in the restoration was found amongst a number of detached plates of *S. arcuatum* from the Cambridge Greensand, and is longitudinally ridged as in the valves of *S. arcuatum*. It possibly belongs to the same species. In any case the only carinal latera known to the writer from the Lower Cretaceous rocks are of the type figured, although they evidently belong to several different species. Judging from the hiatus between the carinal latus and rostral latus, an inframedian latus was undoubtedly present, and was probably very like the homologous valve in *S. fossula* from the Upper Senonian.

The specimen of *S. arcuatum* here figured (text-fig. 65, 6) is, up to the present, the oldest fossil *Scalpellum* from which one can gain any idea of the appearance of the complete capitulum. It comes from the Albian (Gault) of Folkestone, Kent, and the only undoubted valves of *Scalpellum* older than this occur in the Aptian (Lower Greensand)\*. These Lower Greensand forms comprise only three species, two of which—*S. simplex* Darwin and *S. accumulatum* Withers—are respectively represented by a single carina; the third, *S. comptum* Withers, is represented by two detached terga.

Our knowledge of these early forms of *Scalpellum* is therefore not very extensive, and the fact that they are represented by such a small number of valves, and those only of carinae and terga, serves to emphasize the importance of this fine example of *S. arcuatum* (text-fig. 65, 6).

A comparison of the carina and tergum of *S. arcuatum* with the corresponding valves of *S. solidulum* Steenstrup, as figured by Darwin (1851, p. 42, pl. i. fig. 8), shows how closely these two species resemble each other. They are evidently related. The

\* This statement is made with full knowledge that certain valves from the Palaeozoic and Jurassic rocks have been referred by various authors to the genus *Scalpellum*. There is, however, not sufficient evidence to justify the reference of these valves to the genus *Scalpellum*. Notwithstanding this, it is possible that some of the Mesozoic Cirripedes referred to *Pollicipes* may eventually be shown to be ancestral forms of *Scalpellum*, but this cannot be done until more is known of the various valves comprising the capitulum.

carinae are easily distinguished, for whilst in *S. arcuatum* the tectum is flatly-arched transversely, and the intraparietes are bent inwards almost at right angles, the tectum in *S. solidulum* is strongly convex, and the intraparietes join to form a prominent crest. Darwin considered the scutum of *S. solidulum* to be like that of *S. arcuatum*, with the exception of the longitudinal ridges being proportionally broader and further apart, closely resembling those in the carina of *S. solidulum*.

Unfortunately the only known complete capitulum from the Cretaceous rocks with which that of *S. arcuatum* can be compared is that of the Upper Senonian species *S. fossula*. In the relative positions of the valves both species are alike, but in the structure of the carina and scutum there are important differences. The intraparietes of the carina of *S. arcuatum* are sharply bent inwards, the upper part of the valve is solid and must have projected freely to some considerable extent. The carina of *S. fossula*, on the contrary, projected freely but little, and the intraparietes form a thin wall on each side of the carina. In *S. arcuatum* the tergo-lateral angle of the scutum is situated much further from the apex than in *S. fossula*, and in this respect is further removed from the more advanced scuta which have the tergo-lateral angle almost in line with the apex, above which the valve is added to, the umbo consequently being sub-central. The valves of *S. arcuatum* are longitudinally ridged, while those of *S. fossula* are smooth.

#### *Affinities of the Species mentioned.*

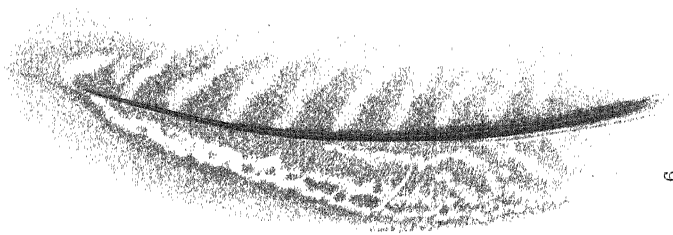
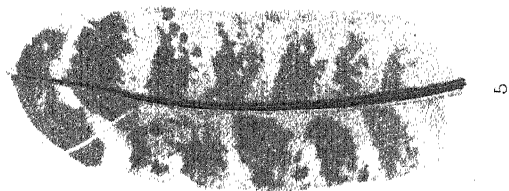
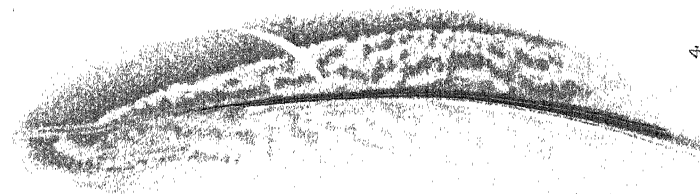
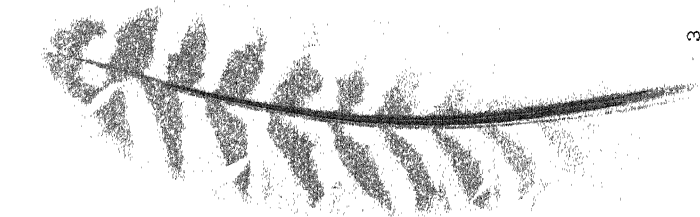
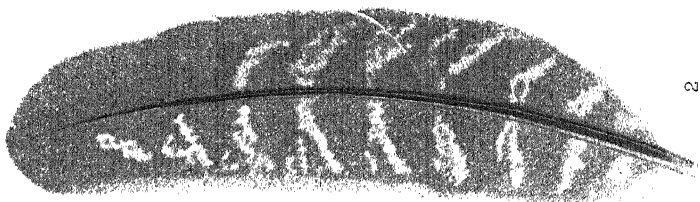
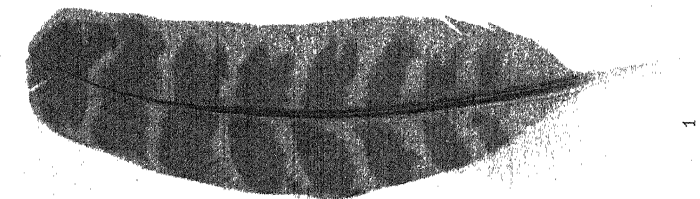
*S. arcuatum* is no doubt an ancestral form of a group of almost exclusively deep-sea species, which Dr. P. P. C. Hoek\* has separated as a sub-genus under the name *Arcoscalpellum*. *S. trilineatum*, *S. accumulatum*, *S. comptum*, *S. maximum* var. *cylindraceum*, and *S. solidulum*, which appear to be related to *S. arcuatum*, possibly belong to the same group, but we know too little of these species to say much about them. *S. simplex* probably does not belong here.

The species embraced by the sub-genus *Arcoscalpellum* have no sub-carina, and it is impossible at present to say whether *S. arcuatum* had a sub-carina or not. The Senonian species *S. fossula* also comes nearest to the subgenus *Arcoscalpellum*, but this species is said by Ed. Hébert† to have a sub-carina, and in view of this it is possible that the Albian *S. arcuatum* also may have had one. Assuming this to be the case, we have two forms agreeing in all essential characters with the forms of *Arcoscalpellum*, except that they (possibly) have a sub-carina. Moreover, the two species differ in the form of the carina, *S. arcuatum* having the intraparietes bent inwards at right angles and

\* P. P. C. Hoek, Oct. 1907, Siboga-Expeditie, Cirripedia Pedunculata, p. 59.

† Ed. Hébert, 1855, Mém. Soc. Géol. France, 2<sup>e</sup> sér. vol. v. p. 356, pl. xxviii. fig. 1 (*S. gallicum* = *S. fossula*).



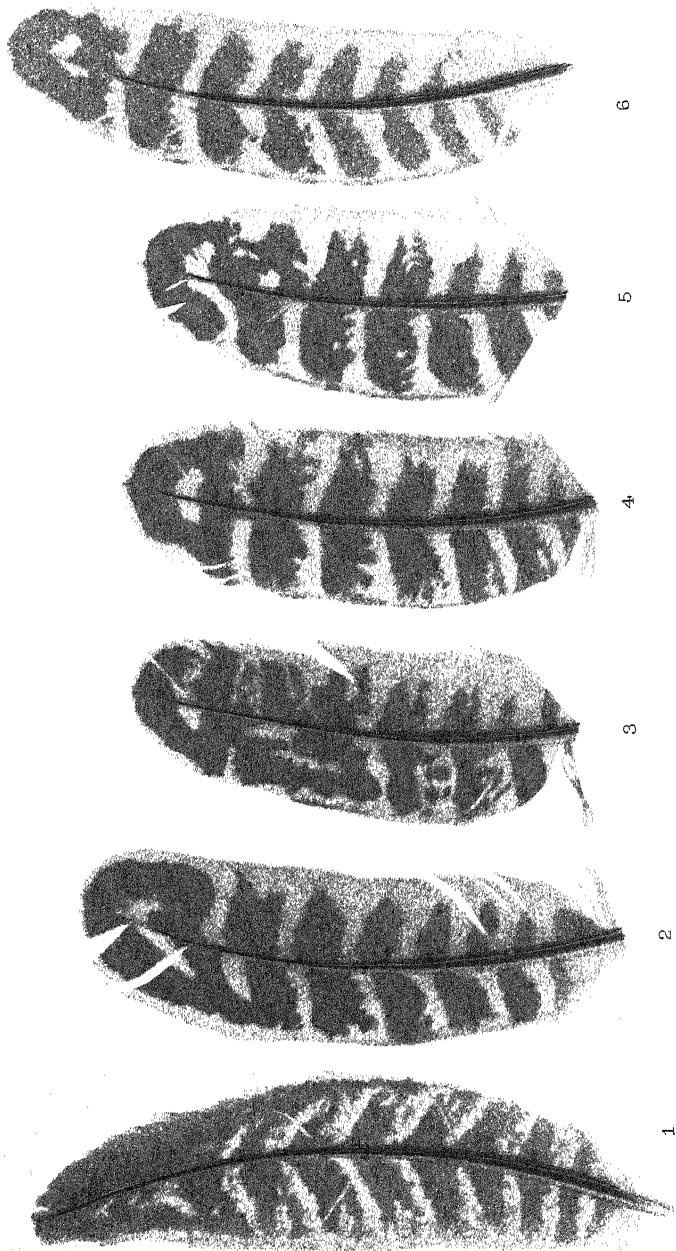


FEATHERS FROM PHEASANTS, ♂ & ♀.

West, Newman ad nat. chr.



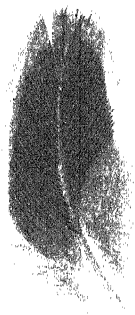




FEATHERS FROM PHEASANTS, ♂ & ♀.

West, Newman ad nat chr.





1



2



3



5



6



4



7



8



9





1



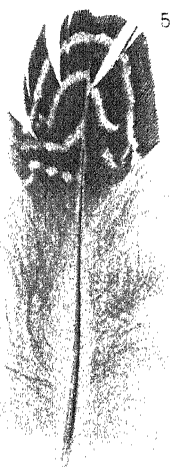
2



3



4



7



8



9

joining, the upper part of the valve being solid and projecting freely, while the carina of *S. fossula* has the intraparietes forming a thin wall on each side of the carina, which is a more advanced type. There is not as yet sufficient evidence to prove whether *S. fossula* was derived from *S. arcuatum* or not. It is patent, however, that from the foregoing species subsequently arose the forms grouped as *Arcoscalpellum* and characterized by a reduction in the number of plates of the capitulum, by a suppression of the rostrum, and a tendency towards the reduction of the pair of infra-median latera.

For help in connexion with this paper I wish to express my indebtedness to Dr. F. A. Bather, Dr. W. T. Calman, Mr. C. P. Chatwin, and Dr. P. P. C. Hoek.

*Key to Species mentioned.*

- |  |  |
|--|--|
| A. Carina without intraparietes, parietes not reaching to the basal margin and bent almost at right angles to the tectum .....   | <i>S. simplex</i> Darwin.                          |
| B. Carina with intraparietes bent inwards and joining, the upper part of the valve solid and projecting freely.  |  |
| 1. Carina with basal margin rounded.....   | <i>S. accumulatum</i> Withers.                     |
| 2. Carina with tectum flatly-arched transversely, and marked with numerous fine longitudinal ridges .....  | <i>S. arcuatum</i> Darwin.                         |
| 3. Carina with tectum flatly-arched transversely, and marked with three prominent longitudinal ridges, one central, and one on either side separating the tectum from the parietes ..... | <i>S. trilineatum</i> Darwin.                      |
| 4. Carina with tectum strongly convex transversely and marked with several longitudinal ridges .....   | <i>S. solidulum</i> Steenstrup sp.                 |
| 5. Carina with tectum strongly convex transversely with smooth surface.....  | <i>S. maximum</i> var. <i>cylindraceum</i> Darwin. |
| C. Carina with intraparietes forming a thin wall on each side of the valve.  |  |
| 1. Carina with tectum and parietes smooth, dorsal surface and inner margin much arcuated .....   | <i>S. hastatum</i> Darwin.                         |
| 2. Carina with tectum bordered on each side by a large, protuberant, flat-topped ridge ... ..  | <i>S. fossula</i> Darwin.                          |

## 28. Experimental Pheasant-breeding.

By ROSE HAIG THOMAS, F.Z.S.

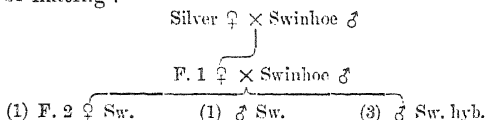
[Received December 4, 1911: Read February 6, 1912.]

(Plates LXIV.-LXVII.\*)

The experiment with which I deal in this paper was undertaken to test the truth of the result of one previously made (P. Z. S. 1909, pp. 884-885), in which it was shown that a male Pheasant had transmitted to his female offspring of the second

\* For explanation of the Plates see p. 545.

generation the female plumage of his species, under the following scheme of mating:—

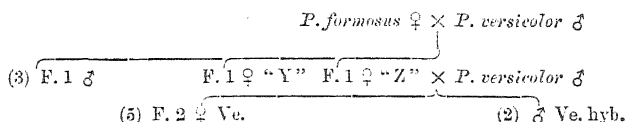


It is to be observed that the Swinhoe male transmitted the pure Swinhoe plumage only to one of his male offspring. As such an isolated instance, though interesting, had small value without the support of other evidence, the following experiment was arranged. I chose species which have mature plumage in five months from hatching, so as to get quicker at the results, instead of, as in the case of *genucus*, waiting eighteen months for the adult plumage of F. 2. *Phasianus formosus*, one of the species selected, is found only on the Island of Formosa; somewhat resembling *P. torquatus*, it differs from it in one special feature; in the cock, the collar, instead of being an even white ring forming a complete circle round the neck, is formed by a deep Vandyke on each side with a narrow connecting-line round the back of the neck but not connected round the throat, an incomplete circle. The other species, *P. versicolor*, the Japanese Pheasant, is too well known to require description; it has no white collar.

Below is appended a table of the differences between the males and females of the two species which might be expected to prove Mendelian pairs.

<i>P. formosus</i> ♂.	<i>P. versicolor</i> ♂.
Moult: Rapid, early.	Moult: Slow, late.
Leg:	Leg:
Colour: Pale bluish grey.	Colour: Dark, reddish grey.
Dimension: Thick.	Dimension: Thin.
Bill: Large.	Bill: Small.
Crest: Pale.	Crest: Dark.
Breast: Rich brown.	Breast: Metallic green.
Tail: Long.	Tail: Short.
All rectrices banded.	Some laterals not banded.
Neck: White collar.	Neck: White collar absent.
Bird: Large.	Bird: Small.
<i>P. formosus</i> ♀.	<i>P. versicolor</i> ♀.
Leg:	Leg:
Colour: Pale bluish grey.	Colour: Reddish grey.
Dimension: Thin.	Dimension: Thin.
Bill: Large.	Bill: Small.
Colour: Greyish green, paler at gape.	Colour: Darker greyish green, same all over.
Crest: Pale ground, black oval spots.	Crest: Dark ground, irregular black patches.
Breast: Pale buff, no pattern.	Breast: Dark buff, thickly patterned.
Tail: Banded pattern on pale ground.	Tail: Banded pattern on dark ground.
Bird: Large.	Bird: Small.
Egg: Large.	Egg: Small.
Calm temperament: quiet, tame.	Excitable temperament: wild, untameable.

Scheme of mating in second experiment :—



The second experiment confirmed the results obtained in the first.

Four skins of the F. 2 ♀'s are exhibited (the fifth female has been kept to breed from), together with skins of pure Versicolor and pure Formosan females, also the skin of the F. 1 ♀ "Z" parent of F. 2. If these are all turned breast uppermost, it is seen at a glance that Versicolor pattern and coloration are present to a certain extent in F. 1 ♀ "Z," mother of the F. 2 generation, and that the F. 2 females appear to be identical with Versicolor in size, pattern, and coloration, except for small differences which might be found existing between individuals of any species. Besides plumage, these five hens had the habit and temperament of the Versicolor, the leg-colour and eye-skin also.

The records of this experiment constantly refer to the quick sharp movements, the wild scared appearance of the F. 2 females, so characteristic of the habits and ways of the untameable Versicolor. If the pen was entered for any purpose, even when exercising the greatest care, there was always a chance the birds might break their necks in their terrified flights and violent dashes against the wire netting, and in this manner one or two were scalped to the bone.

A list of the Versicolor characters found in the F. 1 females is interesting, for there are certain characters which can only be classified in the living bird: Leg-colour, eye-skin, bill, moult, habit, temperament, voice.

F. 1 ♀ "Z" (*P. formosus* ♀ × *P. versicolor* ♂).

Parent of	Eye-skin.	} Versicolor.
F. 2 (Fo. ×	Crest.	
Ve. × Ve.).	Neck.	
	Flank.	
	Breast.	
	Interscapulars.	
	Scapulars.	
	Secondaries.	
	Back.	
	Size of egg.	
	Tail .....	Formosan.
	Bill.	} Hybrid.
	Primaries.	
	Dimension.	
	Leg.	



F. 1 ♀ "Y."

Parent of  
*inter se* F. 2.

Eye-skin.

Crest.

Neck.

Breast.

Flanks.

Interscapulars.

Scapulars.

Secondaries.

Back.

Size of egg.

*Versicolor.*Leg ..... *Formosan.*

Bill.

Primaries.

Dimension.

Tail.

*Hybrid.*

In both F. 1 females the size of egg was transmitted by the Versicolor male.

5 F. 2 ♀.

Crest.

Neck.

Flank.

Breast.

Legs.

Bill, size and colour.

Interscapulars.

Scapulars.

Secondaries.

Primaries.

Tail.

Back.

Dimension.

Habit of moult.

Temperament.

*Versicolor.*

The fifth female, reserved to breed from, has a pale grey stripe down the back of the flank of one leg.

The presence of a mosaic of pale grey and dark grey seen in the legs of F. 1 in this experiment led to the inference that the two parents had severally pale grey legs and dark grey legs, which an immediate examination of the Formosan and Versicolor species confirmed. A curious independent double segregation of allelomorphs was observed in the autumn of 1911 in the crests of the F. 1 males. The centre feathers were dark—colour Versicolor; fully developed, rapid early moult—habit Formosan: the feathers on the outer edge of the crest were pale—colour Formosan;

undeveloped, many still in the quill—habitat Versicolor: two Mendelian pairs coupled in each parent yet repulsing one another in the same area in F. 1. An examination made at the same time of the Formosan male showed the crest fully developed, and an inspection of the Versicolor male showed the crest undeveloped, mostly still in the quill.

F. 1 generation is to me always the most interesting in these artificial Pheasant crosses. For Mendelian segregation already shows, and it is sometimes possible to select the strain of parentage desired to reappear more strongly in the F. 2 generation. Also F. 1 occasionally produces remarkable mosaics of sex—a sort of sex-hybridism accompanied by sterility and extraordinary developments of plumage in the female, phenomena I will not touch upon now. To illustrate more clearly the points I wish to bring to your notice, here is a selection of secondaries (3rds from the last primary) extracted from the wings of the parent species and of all the birds connected with the experiment (Pl. LXIV.): the Formosan male secondaries have a peculiar Vandyke pattern like a feather laid on a feather, and the female secondaries of this species are banded, both are extremely light in colour. The Versicolor male secondaries have a mottled grey oblique banding on a very dark grey ground; the female secondaries of this species are rich brown, with wide bands of darker brown; also placed in the same frame are the secondaries of F. 1 and F. 2 males and females. After examining the parents' secondaries, we perceive that the Versicolor male has transmitted to his female offspring of the F. 1 generation the female secondaries of his species, and that conversely the Formosan female has transmitted to her male offspring of the F. 1 generation a pattern resembling the male secondaries of her species on one vane, though not on the other vane of the feather. In the F. 2 generation ("Fo  $\times$  Ve.  $\times$  Ve." Pl. LXV.) the influence of the Versicolor male on his female offspring continues in pattern and size and more or less in colour, for in F. 2 females the secondaries seem to be Versicolor, with slight differences of colour not unlikely to be found between individuals of the same species; whilst the F. 2 male secondaries, though most resembling Versicolor, are somewhat hybrid in size and pattern, and still show slight traces of Formosan influence.

A selection of interscapulars extracted from the parents and from the two generations of the Formosan Versicolor cross is shown; the females are in one frame, the males in another, and in these the same phenomena appear. Those of the F. 1 females seem to be Versicolor in pattern and colour, as also do the five F. 2 females, with certain modifications that might be readily found amongst individuals of a pure race (Pl. LXVI.). The frame containing the male interscapulars shows amongst the F. 1 males a Formosan and also a hybrid pattern, whilst the F. 2 males are also hybrid (Pl. LXVII.).

The phenomenon of pattern-transference has occurred in all my Pheasant crosses; sometimes from the male to the female, or

conversely from the female to the male, or a pattern may be transferred from one area in the parent species to another area in the F. 2 offspring. I have noticed that these pattern-transferences are inclined to remain fixed and constant.

Colour-transference also takes place, and sometimes where it has occurred seemed to inhibit the appearance of pattern.

One instance was noticed where the breasts of the males of the two races crossed, *Th. amhersti* and *Th. picta*, differing widely in colour, both colours were found on the breast of F. 2 *Th. obscura*, the red of *picta* overlying the metallic green of *amhersti*.

These appear to be the results of the second experiment:—

- (1) The male parent transmitted to his F. 1 female offspring much of the female plumage of his species and the dimension of the egg.
- (2) The female parent transmitted to her F. 1 male offspring much of the male plumage of her species.
- (3) In the F. 2 generation, the offspring of F. 1 female × Versicolor male, the Versicolor male seems to have transmitted every character—bill, leg-colour, plumage, habit, and temperament—of the female of his species to his F. 2 female offspring, whilst he has not transmitted every character of the male of his species to his F. 2 male offspring; repeating exactly the results of the original experiment with *gennans*.

Are we, then, to suppose that some of the gametes of this Versicolor male contained all the factors representing the temperament and habit, the colour, pattern, and dimension of plumage, leg, and bill, and the bulk of the female of his species and even the factor for size of egg, with the one exception of the factor for the sex to which these belonged?

To the practical experimentalist, to the non-mathematical simple observer, the hypothesis is difficult to conceive.

These phenomena seem to be of the nature of a sex-limitation opposed to expectation.

I have read with much interest Mr. Doncaster's account of gametogenesis in the Gall-fly, also his researches on sex-limitations published in 'Genetics,' and am interested to know how he would consider the above facts in relation to his theory of sex: Male gametes ♂ O female gametes ♀ with selective fertilisation between the male gamete O (a non-determinant of sex) and the female gamete ♂.

I hope the material collected in these two experiments may be thought of sufficient importance for the higher students of Genetics to give it some attention, when probably the apparently complicated problem will receive a simple explanation.

## EXPLANATION OF THE PLATES.

## PLATE LXIV.

♂ & ♀ Secondaries (3rd from primary) of the two Parent species  
and of F. 1 (Fo. × Ve.).

1. *P. versicolor* ♀. Horizontally set, broad bands, bifurcated ends; ground-colour brown.
2. *P. versicolor* ♂. Mottled light bands V-shaped, apex towards rachis; ground-colour dark grey.
3. *P. formosus* ♀. Obliquely set narrow bands, pointed ends; ground-colour nearly white.
4. *P. formosus* ♂. Vandyke pattern, light, mottled; ground-colour light grey.
5. F. 1 ♀ "Z" (*P. form.* ♀ × *P. vers.* ♂). Colour, banding, length of feather, *versicolor*; a similar mottling to that here seen is found on the 3rd Secondaries of a pure *versicolor* ♀ unrelated now living in my pheasantry.
6. F. 1 ♂ "C" (*P. form.* ♀ × *P. vers.* ♂). Left vane Vandyke, Formosan ♂ pattern. Right vane hybrid banding. Colour hybrid.

## PLATE LXV.

♂ & ♀ Secondaries (3rd from primary) of F. 2 (Fo. × Ve. × Ve.).

1. F. 2 ♂ "G" (F. 1 Fo. × Ve. ♀ × *P. vers.* ♂). Pattern of banding nearest to *versicolor* ♂. Colour hybrid.
2. F. 2 ♀ ♀ (F. 1 Fo. × Ve. ♀ × *P. vers.* ♂).
3. "C" |
4. "E" |
5. "H" |
6. "F" |
7. "B" |

Although slight differences exist between these five secondaries, yet the length and colour of them, the horizontal setting of the bands, their breadth and bifurcated ends, are all pure female *versicolor* characters.

## PLATE LXVI.

♀ posterior interscapulars of the two Parent species, of F. 1 and F. 2.

1. *P. versicolor* ♀.
2. *P. formosus* ♀ (parent of F. 1).
3. F. 1 ♀ "Y" (parent of *inter se* F. 2). Pattern transference. Pattern found on several *anterior* interscapulars of *P. versicolor* ♀.
4. F. 1 ♀ "Z" (parent of F. 2, Fo. × Ve. × Ve.).
5. F. 2 ♀ "E" (moult completed). ♀ *versicolor* posterior interscapular pattern.
6. F. 2 ♀ "F" (moult completed). Pattern transference. The pattern seen on these two feathers is found on some *anterior* interscapulars of ♀ *versicolor*.
7. F. 2 ♀ "H" (moult completed).
8. F. 2 ♀ "C" (aged 4 months, moult incomplete). Pattern found amongst *posterior* interscapulars on ♀ *versicolor*.
9. F. 2 ♀ "B" (moult completed). Pattern found amongst *anterior* and *posterior* interscapulars on ♀ *versicolor*.

Note, July 2nd, 1912.—A number of posterior and anterior interscapulars extracted from a living female *versicolor* in my pheasantry showed all the patterns figured on Plate LXVI.

## PLATE LXVII.

♂ posterior interscapulars of the two Parent species, of F. 1 and F. 2.

- |                              |                            |
|------------------------------|----------------------------|
| 1. } <i>P. versicolor</i> ♂. | 3. } <i>P. formosus</i> ♂. |
| 2. }                         | 4. }                       |

5. F. 1 ♂ "A" (Fo.×Ve.). Similar patterns found on posterior interscapulars of ♂ *versicolor*.
6. F. 1 ♂ "B" (Fo.×Ve.). Coarser lines but same pattern as found in some posterior interscapulars on ♂ *versicolor*.
7. F. 1 ♂ "C" (Fo.×Ve.). Similar pattern found amongst posterior interscapulars on ♂ *versicolor*.
8. F. 2 ♂ "A" (Fo.×Ve.×Ve.).
9. F. 2 ♂ "G" (Fo.×Ve.×Ve.). Pattern found amongst interscapulars on ♂ *versicolor*.

*Note, 2nd July, 1912.*—A number of posterior and anterior interscapulars were extracted from a male *versicolor* now living in my pheasantry; amongst these were found all the various patterns pictured on Plate LXVII. There is a difference between central and lateral interscapulars, the centrals have the pattern both sides, the left laterals have the pattern on the left side, the right laterals have the pattern on the right side.

27. A List of Moths of the Family Pyralidæ collected by Felix B. Pratt and Charles B. Pratt in Dutch New Guinea in 1909-10; with Descriptions of new Species.  
By Sir GEORGE H. KENRICK, F.Z.S.

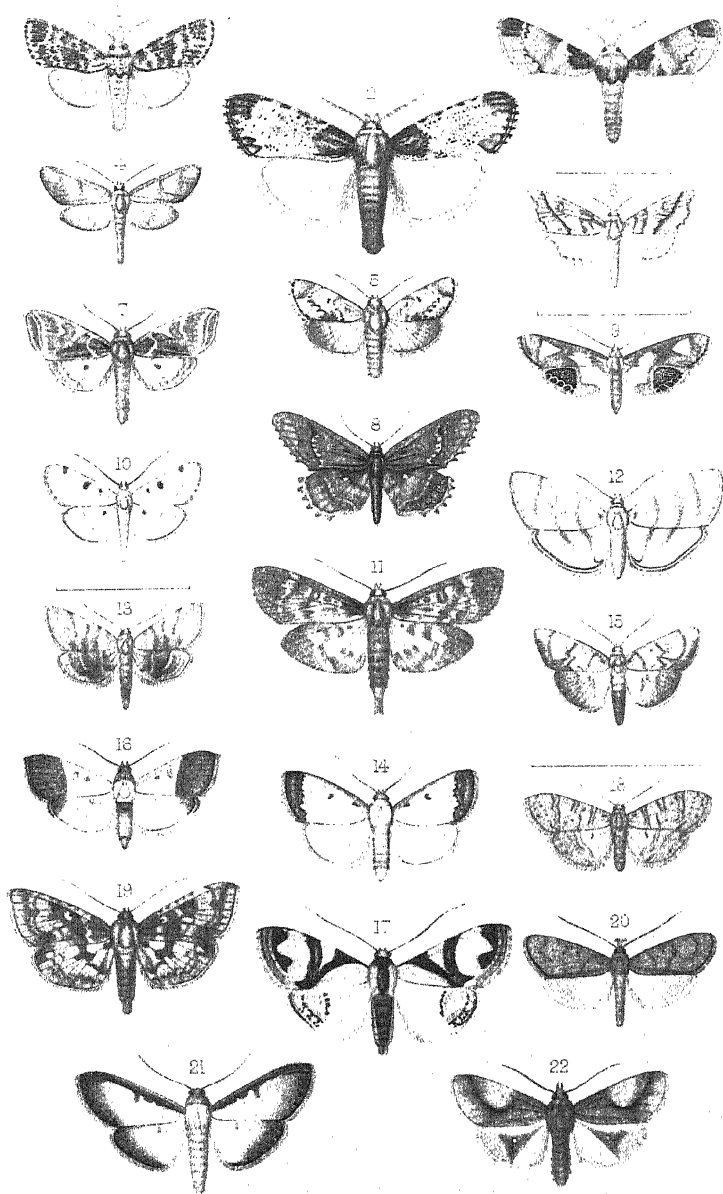
[Received January 30, 1912: Read March 19, 1912.]

(Plate LXVIII.†)

INDEX.	
Systematic:—	Page
<i>Macalla arruensis</i> , sp. n. ....	547
<i>M. olivialis</i> , sp. n. ....	547
<i>M. mioswari</i> , sp. n. ....	547
<i>Stericta rurealis</i> , sp. n. ....	548
<i>Perisyntrocha suffusa</i> , sp. n. ....	548
<i>Ambia novaguineensis</i> , sp. n. ....	549
<i>Margarosticha plumbealis</i> , sp. n. ....	549
<i>Brevicella emarginata</i> , gen. et sp. n. ....	549
<i>Sceliodor grisealis</i> , sp. n. ....	550
<i>Entephria mioswari</i> , sp. n. ....	550
<i>E. grisealis</i> , sp. n. ....	550
<i>Pagoda fumosa</i> , sp. n. ....	551
<i>Sylepta dinawa</i> , sp. n. ....	551
<i>Glyphodes magnificalis</i> , sp. n. ....	552
<i>G. nigricincta</i> , sp. n. ....	552
<i>G. pseudocæsalis</i> , sp. n. ....	552
<i>Omphisa variegata</i> , sp. n. ....	553
<i>Noorda arfakensis</i> , sp. n. ....	553
<i>Piloerocis angulifera</i> , sp. n. ....	553
<i>Pyrausta flammealis</i> , sp. n. ....	554
Variation:—	
<i>Glyphodes Pfeifferæ</i> .....	554
<i>Calamachrous albipunctalis</i> .....	554

After some considerable experience in British New Guinea, the two sons of Mr. A. E. Pratt made several attempts to explore various portions of the Dutch territory, and although disappointed in some directions they made a very successful ascent of the Arfak Mountains, formerly visited by d'Albertis, and spent a considerable

\* For explanation of the Plate see p. 555.



Horace Knight del et lith.

West, Newman col.

PYRALIDÆ FROM DUTCH NEW GUINEA.



time in the vicinity of two lakes, which proved to be excellent collecting-grounds for the lepidopterist.

Although for the most part the insects were the same as those collected in British New Guinea in the south, a fair number of different species occurred, a list of which I give herewith, together with descriptions of new species.

The island of Mioswar, on the north-east coast, was also visited; but the nights were unfavourable for collecting and few moths were taken, although it proved to be an excellent locality for *Lycenidae*.

The specimens were nearly all taken at light, as in the case of those enumerated in my former list.

Sub-fam. *EPITASCHINÆ*.

*MACALLA SYRICHTUSALIS* Walk.

*MACALLA ARRUENSIS*, sp. n. (Pl. LXVIII. fig. 3.)

Head, legs, antennæ, and palpi fawn-colour; abdomen the same, with darker segments at the tuft; tarsi dark ringed with paler.

Fore wing fawn-colour, with a dark brown basal patch outwardly oblique followed by a whitish irregular spot on the costa and reaching as far as the bottom of the cell. Following this on the costa is a darker mark developing into a faint central shade. Beyond this is a curved postmedial line ending in a white mark on the costa, and at the apex there is a dark patch.

Hind wing pale ochreous; fringes pale.

Exp. 32 mm.

From Arfak Mts., 4000 ft.; but there is an undescribed specimen from Arru in the British Museum.

*MACALLA OLIVALIS*, sp. n. (Pl. LXVIII. fig. 1.)

Head, legs, palpi, and thorax olive and white; antennæ brown; abdomen pale grey.

Fore wing olive-green with white markings; three equidistant white spots on the costa, an antemedian interrupted white band, a median interrupted white line, and a postmedian distinct white line preceded by an irregular white blotch which does not reach the costa or the inner margin; a subterminal white line; fringe orange and white; underside of fore wing with a number of large silvery scales in the cell and at the base of the wing.

Hind wing grey, semi-hyaline; fringes paler.

Exp. 29 mm.

Arfak Mts., Dutch New Guinea.

*MACALLA MIOSWARI*, sp. n. (Pl. LXVIII. fig. 5.)

Head, thorax, antennæ, and palpi reddish ochreous; legs darker, ringed with ochreous.

Fore wing pale ochreous with chestnut patches, one at the base



terminating in a dark antemedian line, one at the apex, and another at the angle. Between these two is an extension of the median pale ochreous area extending to the hind margin: an angulated dark postmedian line; a small dark central spot and a dark mark on the inner margin between the lines.

Hind wing grey. Fringes of both wings bright chestnut.

Exp. 27 mm.

Island of Mioswar, Dutch New Guinea.

*STRICTA RUREALIS*, sp. n. (Pl. LXVIII. fig. 2.)

Head, antennæ, and palpi pale ochreous; patagia chestnut; abdomen pale at the base, but with chestnut tuft; legs dark, paler at the joints.

Fore wing ochreous, with a yellower shade along the costa and the raised scales red. A basal patch reddish chestnut, bounded obliquely and extending along the inner margin nearly halfway. An apical chestnut patch and a smaller patch at the angle.

Hind wing pale ochreous, with a fine marginal line darker. Fringes ochreous, but darker at the apex.

Exp. 44 mm.

Arfak Mts., 4000 ft.

Sub-fam. PYRALINÆ.

*CURENA EXTERNALIS* Walk.

Sub-fam. HYDROCAMPINÆ.

*AULACODES BRUNNEALIS* Hmps.

*AULACODES METALOXALIS* Hmps.

*NYMPHULA CHRYSÆIS* Meyr.

*NYMPHULA POLYSTICTALIS* Hmps.

*CLUPEOSOMA POLUSALIS* Walk.

*PILETOCERA CEGIMISALIS* Walk.

*PILETOCERA DIPLATYLA* Walk.

*PILETOCERA TORSICUTALIS* Hmps.

*NEOGENESIS FLAVOPLAGIALIS* Hmps.

*PERISYNTRICHA SUFFUSA*, sp. n. (Pl. LXVIII. fig. 4.)

Head, antennæ, palpi, and legs pale ochreous; thorax darker, with paler patagia; abdomen grey, with pale band at base and paler rings at the segments.

Fore wing hyaline, pale golden; a darker margin to the costa. A patch of dark scales at end of cell, developing into a triangular fuscous mark reaching to the inner margin; the apical area of the wing is occupied by a fuscous patch, with the exception of a pale patch extending from the costa to the central nervure.

Hind wing pale with fuscous margin, broad at apex but disappearing at the angle; fringes pale.

Exp. 24 mm.

Arfak Mts., 4000 ft.

*AMBIA NOVAGUINENSIS*, sp. n. (Pl. LXVIII. fig. 6.)

Head, legs, antennæ, palpi, and thorax brown.

Fore wing whitish, with numerous brown markings; two antemedian lines containing a white spot near the costa; a dark spot at end of cell, with a white triangular centre; an oblique line running from near apex to middle of inner margin, followed by a darker space containing five triangular white spots with dark outer margins.

Hind wing white, with an irregular dark median line and a dark subterminal line.

Exp. 18 mm.

This insect has veins 4 and 5 stalked in both wings.

Warmasin Lake, Arfak Mountains, 6000 ft.

*MARGAROSTICHA PLUMBEALIS*, sp. n. (Pl. LXVIII. fig. 9.)

Head, legs, antennæ, and thorax pale chestnut; patagia white; abdomen bright chestnut, with black tuft.

Fore wing bright chestnut, with silvery-white blotches: the first is square and extends from the median nervure to the hind margin, the second is triangular and near the apex; before the apex itself is a narrow white streak.

Hind wing chestnut, with a broad white transverse band; beyond this is a lead-coloured round patch reaching the outer margin: it is in reality black, with a number of scattered white scales; on the outer edge of this are three black dots, each having a centre of chestnut, and between them silvery-white dots.

Underside silvery, with the markings of the upper wings showing through; fringes darker.

Exp. 22 mm.

Arfak Mts., 4000 ft.

New genus under sub-fam. Hydrocampinæ:—

*BREVICELLA* (type *emarginata*, ♀).

Palpi porrect, twice the length of head, not scaled: antennæ simple; legs not hairy; tibiæ with usual spines. Hind wings with long hairs on parts of the costa.

Venation—Fore wing: 2 and 3 stalked; 4, 5, 6, 7 from cell; 9 and 10 stalked, with 8–11 present. Hind wing: 2 and 3 stalked slightly; 4, 5, 6 from cell; 7 stalked with 8.

*BREVICELLA EMARGINATA*, sp. n. (Pl. LXVIII. fig. 8.)

Body and wings dark brown; a postmedian curved line bordered within by seven triangular whitish dashes; at the upper end of

this line is an oblique intensely black dash reaching nearly to the costa.

Hind wing with an antemedian whitish spot and a postmedian darker band. There is a narrow darker marginal line to both wings, and the fringes, which are dark, are strongly emarginate.

Exp. 30 mm.

Momi-Arfak, 4000 ft.

*SCELIODES GRISEALIS*, sp. n. (Pl. LXVIII. fig. 7.)

Head, antennæ, legs, and palpi ochreous; thorax and abdomen pale brown; tuft pale.

Fore wing ochreous, powdered with black scales and with three white angulated streaks, the first much angulated before the middle, the second beginning in the middle of the costa and narrowing to a point on the lower edge of cell, the third also from the costa extending as an angulated fine line to the middle of the wing; a subterminal ill-defined whitish band, in which is a dark subterminal line followed by a dark cloud.

Hind wing whitish, with two dark dots on the disc, a dark subterminal line followed by a dark cloud; fringes brown.

Exp. 30 mm.

Arfak Mts., 4000 ft.

Sub-fam. PYRAUSTINÆ.

*XANTHOMELÆNA SCHEMATIAS* Meyr.

*ENTEPIHRIA GLAUCIAS* Meyr.

*ENTEPIHRIA MIOSWARI*, sp. n. (Pl. LXVIII. fig. 10.)

Head, antennæ, legs, and palpi silvery white. Thorax and abdomen white, the latter with black markings on three or four of the last segments. Fore wing white, a small soot-black spot near the base of the cell and a larger round one at the end. Before the apex is a costal black spot, from which springs a pale transverse ochreous line reaching the inner margin. In some specimens there is a dark spot at the apex, and in all the hind margin is dark.

Hind wing white, with a small dark spot near the base and a thin median line; hind margin and fringes darker.

Exp. 24 mm.

Island of Mioswar, Dutch New Guinea.

*ENTEPIHRIA GRISEALIS*, sp. n. (Pl. LXVIII. fig. 12.)

Head, palpi, antennæ, and legs silvery white; thorax and abdomen white, the last three segments darker above.

Fore wing white shaded with grey; two transverse ochreous antemedian lines, the first somewhat obscure; a median line from inner margin to vein 2, where it disappears in a broad shade; a transverse distinct line from costa to vein 2 beyond the cell.

Hind wing white; a transverse dark line from angle to costa and another from costa beyond cell to vein 2.

The margins of both wings are bordered by a dark, thin, double line enclosing a paler portion. Fringes white.

Exp. 32 mm.

Arfak Mountains, Dutch New Guinea.

*REHIMENA CISSOPHORA* Turner.

*ZINCKENIA LOPHOCERALIS* Hmps.

*AGROTERA PYROSTICTA* Hmps.

*PAGYDA BOTYDALIS* Snell.

*PAGYDA FUMOSA*, sp. n. (Pl. LXVIII. fig. 13.)

Head, legs, antennæ, and palpi straw-colour; thorax and abdomen rather more orange.

Fore wing straw-colour, a short, orange, transverse line near base; an antemedian and a postmedian line, the middle line curved, dark orange; an oblique curved band of pale orange from apex to hind margin and a paler marginal band.

Hind wing suffused with a smoky patch in which there are three whitish transverse lines and a dark fine marginal line; fringes paler.

Exp. 22 mm.

Arfak Mts., 4000 feet.

*CAPRINIA DIAPHANALIS* Walk.

*PHRYGANODES EREBUSALIS* Hmps.

*PHRYGANODES ANALIS* Hmps.

*PHRYGANODES USITALIS* Guen.

*PHRYGANODES TETRAPLAGALIS* Hmps.

*PHRYGANODES CENTRABALIS* Hmps.

*NACOLEIA PERDENTALIS* Hmps.

*PRORODES MIMICA* Swinh.

*SYLEPTA POLYDONTA* Hmps.

*SYLEPTA LEUCODONTA* Hmps.

*SYLEPTA DINAWA*, sp. n. (Pl. LXVIII. fig. 11.)

Head, thorax, legs, antennæ, and palpi dark brown; abdomen dark brown, with a conspicuous pale ochreous tuft and a pair of black tufts of hair at base. Fore wing pale ochreous clouded with dark grey; an irregular dark antemedian line and a vague postmedian line with a branch towards the angle; the apex is broadly

margined with dark; below the costa at end of cell is a lunated mark and there is another smaller one nearer the base.

Hind wing pale semihyaline, with traces of dark ante- and postmedian lines, the hind margin with a broad dark shade; fringes pale.

Exp. 42 mm.

Dinawa, British New Guinea.

GLYPHODES POLYZONALIS Hmps.

GLYPHODES MAGNIFICALIS, sp. n. (Pl. LXVIII. fig. 17.)

Head, palpi, and antennæ black; legs and underside golden. Thorax black, with collar and patagia ochreous; abdomen black above.

Fore wing pale ochreous; an oblique black band beginning as a fine line on the base of the costa reaches a point two-thirds along the inner margin, from this there stretches a nearly vertical black band with curved outer side to the costa. There is a subterminal cloud of brown intersected by two fine metallic purple lines, on the inner side of this are two triangular black marks united in the middle. All the black marks are shot with metallic blue.

Hind wing pale ochreous, with an interrupted dark postmedian line. On the middle of the edge of the wing are three white-centred black dots on a faint bright line.

Exp. 40 mm.

Arfak Mts., 4000 feet.

The only specimen is a female.

GLYPHODES NIGRICINCTA, sp. n. (Pl. LXVIII. fig. 16.)

Head, palpi, and antennæ dark brown; legs white, the joints dark brown on the outer side; front of thorax black; patagia white; abdomen grey, with a black band at base.

Fore wing white, a dark grey spot in the middle of the cell and a second at the end; the outer half of the wing very dark grey.

Hind wing white, with grey lunule and dark grey apical patch. Fringes smoky, fading into white towards the angle of the hind wing.

Exp. 26 mm.

Arfak Mts., 4000 feet.

GLYPHODES PSEUDOCÆSALIS, sp. n. (Pl. LXVIII. fig. 18.)

Differs from *cæsalis* Wlk. in the absence of hyaline patches, in having the fringes unspotted whereas in *cæsalis* the dark spots give the wings a distinctly emarginate appearance, and in the markings of the fore wing: these consist of a basal line indicated by dots, antemedian, median, and postmedian lines, each of which is double and the inner lines of the median and postmedian are connected. In *cæsalis* these double lines are wider apart, more irregular, and filled in with darker instead of with the ground-colour as in *pseudocæsalis*. Beyond the postmedian line in *cæsalis*

is a dark patch with four pale lunules, which are absent in *pseudocæsalis*.

Exp. 30 mm.

Arfak Mts., Island of Mioswar, Mt. Goliath, and British New Guinea.

It is possible that there is another allied species, but it may be simply a larger form of *cæsalis*.

*Pygospila tyres* Cram.

*Crocidolomia binotalis* Zell.

*Sameodes polythliptalis* Hmps.

*Omphisa repetitalis* Moore.

*Omphisa variegata*, sp. n. (Pl. LXVIII. fig. 19.)

Head, legs, antennæ, and palpi chestnut-brown; thorax chestnut-brown, the patagia pale; abdomen darker, spotted with paler on back.

Fore wing pale ochreous with brown markings.

Fore wing: basal patch brown, an antemedian and a postmedian line enclosing a darker band which does not reach the costa, but which surrounds a conspicuous subtriangular pale spot near the end of the cell; beyond this is an angulated line followed by a darker shade; costa with six lunules.

Hind wing pale, with an irregular sharply-defined median band and a double outer dark line.

Exp. 32 mm.

Island of Mioswar, Dutch New Guinea.

*Noorda nigripunctalis* Hmps.

*Noorda arfakensis*, sp. n. (Pl. LXVIII. fig. 14.)

Antennæ and palpi brown; legs white, with brown tips to the joints; head ochreous; thorax white; abdomen whitish, the last segment grey, anal tuft white.

Fore wing creamy white, the costa reddish; a dark brown dot at base, another at the beginning of the cell, and a third at the end; a dark brown annulated subterminal line; the remainder of the wing to the outer margin of a chestnut colour mottled with darker.

Hind wing white. Fringes pale brown, shading into white at the angle of the hind wing.

Exp. 30 mm.

Arfak Mts., 4000 feet.

*Dausara amethystina* Butler.

*Pilocrocis* (a subdivision of *Crocidophora*) *angulifera*, sp. n. (Pl. LXVIII. fig. 15.)

Head, legs, antennæ, and palpi straw-colour; thorax and abdomen pale golden, the last few segments becoming fuscous.

PROC. ZOO. SOC.—1912, No. XXXVII.

37

Fore wing pale golden, a very short basal dark line, an oblique antemedian line, a sharply angulated median line, a regular curved postmedian line (all these are dark fuscous and the last is lost in a fuscous patch which extends from the middle of the hind margin halfway up the hind margin).

Hind wing pale at base, with the whole of the outer portion dark fuscous, the boundary between these is marked by a very irregular angulated line. Fringes rather paler.

Exp. 28 mm.

Arfak Mts., 4000 feet.

*APHYTOCEROS GROSALIS* Meyr.

*CURICTA OPPOSITALIS* Walk.

*PYRAUSTA OCCULTILINEA* Walk.

*PYRAUSTA ALENTIALIS* Snell.

*PYRAUSTA DEDUCTALIS* Walk.

*PYRAUSTA FLAMMEALIS*, sp. n. (Pl. LXVIII. fig. 20.)

Male with a tuft of hair at base of fore wing below and a strong fold of costa extending to end of cell; female with a smaller tuft of hair; both sexes have the base of the antennæ surmounted by a tuft of hair, but this is larger in the male. Head, legs, and antennæ pinkish brown, also palpi; abdomen ochreous above, darker below; thorax and patagia flame-colour.

Fore wing flame-colour, with three transverse fine dark lines: the first ante median and oblique, the second median and angulated in the middle, the third angulated and not reaching below the third nervure; all the margins of the wing are darker.

Hind wing uniformly straw-colour with fringes slightly darker; fringes of fore wing dark. In the female the flame-colour is replaced by Indian yellow.

Exp. 30 mm.

Arfak Mts., 6000 feet.

In addition to these species I have figured two varieties of species already described:—

Pl. LXVIII. fig. 21 represents a form of *Glyphodes pfeifferæ* in which the marginal border to both wings is much deeper than any specimen I have received from New Guinea.

Pl. LXVIII. fig. 22 represents a form of *Calamachrous albipunctalis* in which the deep maroon-purple of the wings of this species is replaced by bright chestnut.

Both of these forms are from the island of Mioswar.

Although in some cases a good series of the species was obtained, in others only single specimens or two examples were taken, so that the differences in sex could not be ascertained.

From this circumstance I am inclined to think that many other

species would turn up if the localities could be worked throughout the year, and I believe any collector willing to face the difficulties of a camp life would be amply rewarded by the results.

I desire to tender my sincere thanks to Sir George Hampson for advice and assistance in regard to species of this large group and for permission to study the excellent collection at South Kensington.

## EXPLANATION OF PLATE LXVIII.

- Fig. 1. *Macalla olivalis*.  
 2. *Stericta rurealis*.  
 3. *Macalla arruensis*.  
 4. *Perisyntrocha suffusa*.  
 5. *Macalla miosuari*.  
 6. *Ambia novaguineensis*.  
 7. *Sceliodes grisealis*.  
 8. *Brevicella emarginata*.  
 9. *Margarosticha plumbealis*.  
 10. *Entephria miosuari*.  
 11. *Sylepta dinawa*.  
 12. *Entephria grisealis*.

- Fig. 13. *Pagyla fumosa*.  
 14. *Noorda arfakensis*.  
 15. *Pilocrocis angulifera*.  
 16. *Glyphodes nigricincta*.  
 17. *Glyphodes magnificatus*.  
 18. *Glyphodes pseudocæsalis*.  
 19. *Omphisa variegata*.  
 20. *Pyrausta flammealis*.  
 21. *Glyphodes pfeifferæ* (var.).  
 22. *Calamachrous albipunctalis* (var.).

## EXHIBITIONS AND NOTICES.

April 2, 1912.

DR. A. SMITH WOODWARD, F.R.S., Vice-President,  
 in the Chair.

The SECRETARY read the following report on the additions that had been made to the Society's Menagerie during the months of February and March, 1912.

## FEBRUARY.

The registered additions to the Society's Menagerie during the month of February were 128 in number. Of these, 50 were acquired by presentation, 29 by purchase, 13 were received on deposit, 19 in exchange, and 17 were born in the Gardens.

The number of departures during the same period, by deaths and removals, was 236.

Amongst the additions special attention may be directed to:—

1 Snow-Leopard (*Felis uncia*) and 1 Musk-Deer (*Moschus moschiferus*), from Nepal, presented by H.M. THE KING on February 29th.

2 Snow-Leopards (*Felis uncia*), from Kashmir, presented by Capt. G. Douglas Oliver, F.Z.S., on February 26th.

2 Jaguars (*Felis onca*), born in the Menagerie on February 20th.

2 Striped Hyænas (*Hycæna hyæna*), from N. Nigeria, presented by H. P. Lobb, Esq., on February 4th.

1 Spurrell's Dormouse (*Graphiurus spurrelli*), from Dunkwa,



Gold Coast, new to the Collection, presented by Dr. H. G. F. Spurrell, F.Z.S., on February 12th.

1 White-capped Redstart (*Chimarrhornis leucocephalus*), from the Himalayas, presented by Alfred Ezra, Esq., F.Z.S., on February 29th.

### MARCH.

The registered additions to the Society's Menagerie during the month of March were 110 in number. Of these 45 were acquired by presentation, 32 by purchase, 21 were received on deposit, 8 in exchange, and 4 were born in the Gardens.

The number of departures during the same period, by death and removals, was 192.

Amongst the additions special attention may be directed to:—

1 Wallich's Deer (*Cervus wallichii*) ♂, new to the Collection, 1 Burrhel (*Ovis burrhel*) ♂, 1 Tahr (*Hemitragus jemlaicus*) ♀, and 6 Tibetan Mastiffs (*Canis familiaris*), from Nepal, presented by H.M. the King on March 13th and 25th.

1 Alpaca (*Lama pacos*) ♂, from Peru, received in exchange on March 5th.

1 Racket-tailed Drongo (*Dissemurus paradiseus*), from India, presented by Alfred Ezra, Esq., F.Z.S., on March 14th.

1 African Tantalus (*Pseudotantalus ibis*), from Southern Nigeria, presented by Sir Walter Egerton, K.C.M.G., F.Z.S., on March 15th.

1 Ashy-headed Goose (*Chloëphaga poliocephala*) bred in Holland, received in exchange on March 22nd.

3 Prairie-hens (*Tympanuchus americanus*), from North America, received in exchange on March 21st.

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Mr. R. I. Pocock, F.R.S., F.L.S., F.Z.S., Superintendent of the Gardens, exhibited a lantern-slide of two Polar Bear cubs (*Ursus maritimus*) born in the Gardens in November 1911, and made some remarks upon the causes of the difficulty experienced in Zoological Gardens in rearing the offspring of this species.

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Mr. C. TATE REGAN, M.A., F.Z.S., exhibited some lantern-slides, prepared from photographs taken by Dr. F. B. Sumner, of a Mediterranean Flatfish (*Platophrys podas*) on sand, gravel, and various artificial backgrounds, showing its power of changing its colour and markings to resemble the ground on which it lies.

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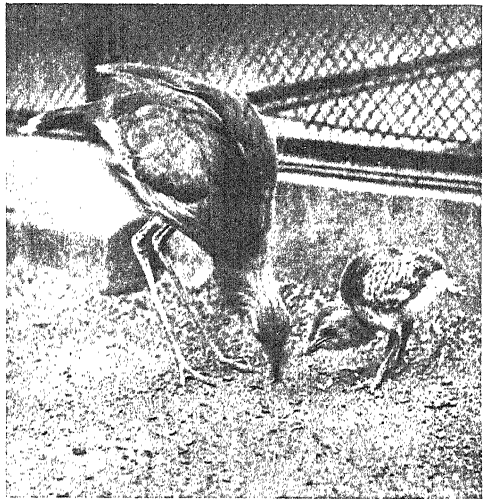
Dr. R. W. SHUFELDT, C.M.Z.S., sent for exhibition the skins of two young Virginia Opossums (*Didelphis virginiana*). These specimens were each about ten weeks old and belonged to the same litter.

The bones of the entire skeleton at this age were quite

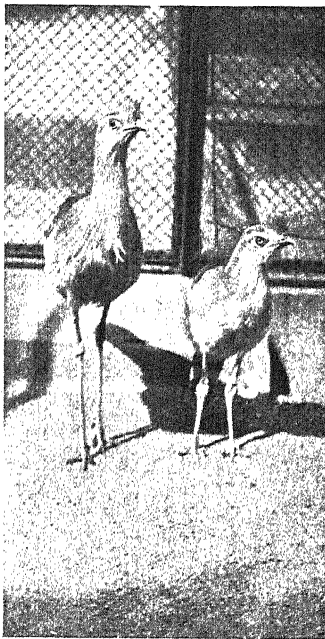




1.



2.



3.



4.

Photos by D. Seth-Smith.

Bale & Danielsson Ltd imp.

YOUNG *CARIAMA CRISTATA*.

elementary in character, especially the terminal vertebræ of the tail, the bones of either carpus and those of the tarsi, and the epiphyses of the long bones, etc. The marsupial bones were well formed in both sexes, and upon either side were nearly as long as the corresponding ilium, and about one-fourth the size in bulk.

According to Flower, the number of vertebræ in the spine of the Virginia Opossum was 7 cervical, 13 thoracic, 6 lumbar, and 26 caudal. This was probably correct for the adult animal of this species, while in subadults, of an age here considered, the last three caudals were not developed, and the three or four anterior to them were in the most rudimentary condition possible.

In both these specimens the dentition in use was as follows :—

$$i \frac{5}{4}, c \frac{1}{1}, pm + m \frac{5}{5} = 42,$$

the third of the cheek-teeth being the molar-like predecessor of the one premolar which changes in Marsupials. Two further molars would have come up in later life, making the adult formula :—

$$i \frac{5}{4}, c \frac{1}{1}, pm \frac{3}{3}, m \frac{4}{4} = 50.$$

The premolars were triangular, sharp-pointed, and flattened from side to side; the molars had numerous sharp cusps and the canines were large and curved.

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MR. D. SETH-SMITH, F.Z.S., Curator of Birds, exhibited, by means of lantern-slides, photographs of the male Peacock Pheasant (*Polyplectron chinquis*) displaying to the female.

The typical display, as depicted in the photographs, resembled very closely that of the Argus Pheasant, the bird facing the female while he lowered the breast to the ground and expanded the wings and tail like a shield, the head being held sideways against one wing.

Mr. Seth-Smith also exhibited photographs (Pl. LXIX. \*) of the young *Cariama cristata* hatched and reared in the Gardens in 1911, and remarked that although young of this species had been hatched in the Menagerie on previous occasions, he believed that this was the first occasion on which the young had been reared to maturity.

The nest was formed of sticks and small twigs on a platform of branches that had been specially erected at about eight feet from the ground in the Eastern Aviary. Of the two eggs laid, one was accidentally broken by the birds, but the other hatched on June 6th, incubation, performed chiefly by the female, having occupied twenty-nine or thirty days. The young bird was covered with down of a pale brown colour mottled with darker brown on the back, that on the head being extraordinarily long and hairlike. It was fed by the parents with small pieces of meat,

\* For explanation of the Plate see p. 558.

mice, hard-boiled egg, and cockroaches. It left the nest at a month old, and at five weeks old may be described as follows:—

Upper parts pale brown, darker and with a rufous shade on the mantle, the rump and upper tail-coverts being dark brown. The crown of the head and neck barred with dark brown; the wings also covered with fine wavy lines of dark brown on a paler ground.

The abdomen and under tail-coverts whitish.

The bill very dark brown, the legs and feet dark grey, and the iris very pale silvery grey.

#### EXPLANATION OF PLATE LXIX.

- Fig. 1. Young *Cariama cristata* 24 days old, in nest.  
 Fig. 2. " " " 30 days old, with parent.  
 Figs. 3 & 4. " " " 2 months old.

#### PAPERS.

30. On a rare Stag (*Cervus wallichii*) from Nepal recently presented to the Zoological Society by His Majesty King George. By R. I. POCKOCK, F.R.S., F.L.S., F.Z.S., Superintendent of the Gardens.

[Received March 19, 1912: Read April 2, 1912.]

(Text-figures 66–71.)

Systematic:	INDEX.	Page
<i>Cervus wallichii</i> Cuv., Western Tibet, text-figs.		
66–69 .....		559
„ <i>hanyu</i> Wagn., syn. <i>cashmeriensis</i> Adams,		
<i>cashmerianus</i> Falc., Kashmir, text-fig. 70		566
„ <i>affinis</i> Hodgs., Choombi Valley, Lhasa, etc.		567
„ <i>macneilli</i> Lydd., Szechuen, text-fig. 71 ...		570
„ <i>kansuensis</i> , nov., Kansu .....		572
Characters of these species tabulated .....		574
<i>Cervus albirostris</i> , Tibet .....		574

From the scientific standpoint the most interesting animal in the collection from Nepal presented by H.M. the King to the Zoological Society was a large Stag belonging to a species (*Cervus wallichii*) which has never been previously exported alive from India, and, so far as available records show, has never been shot or preserved by any English sportsman, and is therefore unrepresented in any of the large museums of the world. The arrival of this specimen, moreover, has made it possible to classify a species which for nearly a century has been a puzzle to all systematic workers on the Deer.

*Cervus wallichii* was described by G. Cuvier (Rech. Oss. Foss. ed. 3, iv. p. 504, 1825\*; ed. 4, vi. pp. 88-89, 1835) from a native sketch, sent to him by Duvaucel, of an animal, one of a pair, according to Blyth, living in the menagerie at Barrackpore and said to have come from Muktinath, north of Dwalagiri in Nepal†. This sketch was reproduced by F. Cuvier & Geoffroy St. Hilaire (Hist. Nat. Mamm. iv. no. 356, 1823), and modifications of it were reproduced subsequently by Jardine‡ and Hamilton Smith§.

Text-fig. 66.

*Cervus wallichii.*

Photograph of Cuvier's figure of the type-specimen.

The main characters of the animal are made clear by the descriptions and figures of the French authors. It was described as dark grey-brown or yellowish grey-brown with pale legs, a

\* I have not seen this edition.—R. I. P.

† In support of this Blanford (Mamm. Brit. India, p. 538), copying Blyth, cites Hardwicke (Tr. Linn. Soc., Zool. xiv. p. 581, 1823). Hardwicke, however, does not there state that the stag from Muktinath he identified as '*C. pygargus*, Pall.' was the type from which the sketch was taken. The coincidence of the dates, however leaves little doubt on this point.

‡ Naturalist's Library, iii. pl. 10, p. 161, 1835.

§ Griffith's Animal Kingdom, iv. p. 103, pl., 1827.

the summit of the croup, forming a very large pure white disk without trace of median dividing dark line. Upon the croup this disk is not emphasized by a bordering of darker hairs; but below the level of the tail, the white on the back of the thighs is set off by a margin of brown. This disk, so far as size is concerned, differs from that of the Wapiti in being narrower below, its width on each side on a level with the tip of the tail only equalling the width of that organ, whereas in the Wapiti the disk at this point is equal to twice the width of the tail.

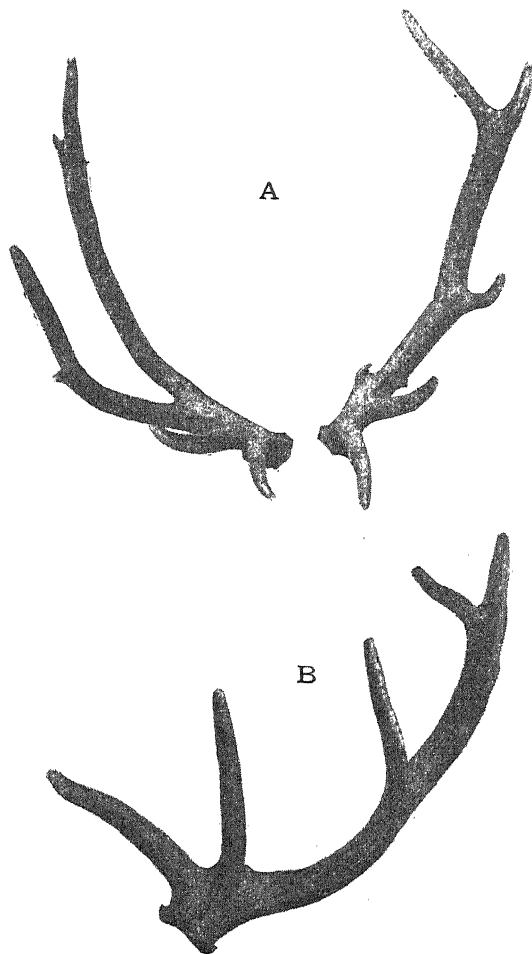
It is also noticeable that the hairs adjoining the croup-disk are quite white at the base, so that if they were elevated or deprived of the yellowish-brown pigment of their distal portions, a far larger white rump patch would be displayed than is normally the case. None of the hairs show signs of speckling apically or elsewhere, and their concealed portion is greyish brown on the body, though darker on the neck. Both on the body and over the croup a very large number of them are curled forwards apically, like those on the croup of the type specimen of *C. wallichii* as described by Cuvier, but a mounted specimen of the Kashmir Stag in the British Museum shows, to a lesser degree, this same peculiarity, which is no doubt a sign of old hair.

The antlers, which were shed early in March on the voyage from India, are short but massive. The right one is abnormal, the left probably normal but, possibly, reduced in size from age degeneracy. Both are brown with pale tips to the tines. In the left antler the burr is short, the brow tine rising about an inch above it. This tine is about  $8\frac{1}{2}$  inches long, projects nearly horizontally forwards and is bent slightly down just before the tip. The bez tine is straight, about half an inch shorter than the brow and diverges from it at an angle of about  $45^\circ$ , their basal separation being about 1 inch. Just above the root of the bez on the inner side there is a short snag. Beyond the bez the beam curves gently outwards and upwards for about  $7\frac{1}{2}$  inches to the origin of the trez, which is about 7 inches long and lightly curved, and lies in approximately the same plane as the bez and brow tines. Above the trez the beam ascends, showing upon the anterior aspect a slight inward inclination, but from the external profile view it exhibits a decided inclination backwards with a light upward curve, its axis lying almost at an angle of  $45^\circ$  to that of the trez, and forming a very obtuse angle with the lower part of the beam, there being a marked concavity behind the root of the trez. It terminates above in two tines, one short and erect and continuing the line of the beam, the other twice as long and inclined upwards and inwards.

The antler is thus five-pointed. It resembles the antlers of the typical specimen in the basal juxtaposition and marked divergence of the brow and bez tines, but, apart from the presence of the trez tine, differs from them in the more upward curvature of the basal part of the beam, which is thus inclined at sharper angles to the axis of the brow and bez tines. In this

latter particular, however, the antlers figured by Blyth are intermediate between those of the example figured by Cuvier and the one just described.

Text-fig. 68.



*Cervus wallichii.*

A. Anterior aspect of the shed antlers.

B. External aspect of left antler.

In the right antler the brow and bez tines resemble those of the left antler; but above the bez the beam bifurcates into



anterior and posterior branches; the former, occupying almost the position of the trez in the normal antler, is stout, 15 inches long, evenly curved upwards and outwards and two-tined, one tine being short and forwardly directed, the other, which is terminal, being long and lightly curved upwards, backwards and inwards. This branch may be described as an attempt at a reduplication of a normal beam. The posterior branch is thinner than the anterior and ascends with an even curvature upwards, outwards and then inwards, to terminate in two tines, an external which is merely a short bud, and an internal which follows the line of the beam without showing any marked inward inclination, although it clearly corresponds to the inwardly inclined terminal tine of the left antler.

Judging from their small size and asymmetry, these antlers may be decadent; but, if so, the left antler has suffered less than the right from that process and less than those of the type specimen of *C. wallichii* described above. Still I do not think it safe to infer that this left antler resembles that of a stag of this species in full vigour. The possibility, however, must be borne in mind.

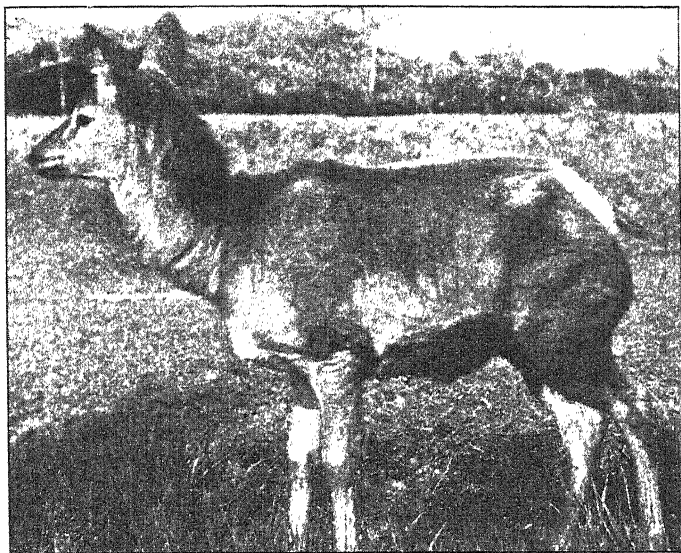
Of the exact geographical area inhabited by *C. wallichii* we have at present no trustworthy information. The type of the species in the Barrackpore menagerie was said by Hardwicke (Tr. Linn. Soc. xiv. p. 581, 1823) to have been brought from Muktinath, away to the north of Dwalagiri in Central Nepal. The example now in the Gardens was presumably in captivity in Nepal, since it was presented to King George by the Maharajah of that country (see note below).

The only other Stag, known to me, which seems to belong to this species is the one which Mr. Lydekker identified from a photograph as *C. affinis* (P. Z. S. 1909, p. 599, fig. 182). This, too, was a captive animal and was alleged to have come from Sikkim. I judge from the size of the rump patch that this stag belongs to *C. wallichii*. Mr. Lydekker described the colour as "very like that of the Hangul with a large white rump-patch." This seems to be correct so far as the size of the rump-patch is concerned; but if the colour of the body was inferred from the photograph, the inference is untrustworthy since the camera is notoriously deceptive in accurately indicating the differences between dark and light tones \* (text-fig. 69).

\* [Note added June 1st, 1912.]—While this paper was in the printers' hands Mr. Lydekker wrote to the 'Field' (May 11th, 1912), on behalf of Col. J. Manners-Smith, to say that the Stag represented by the photograph above discussed is the same individual as the one presented to the King by the Maharajah of Nepal. The history of this animal was recorded by Col. Manners-Smith in the 'Field,' July 31st, 1909, p. 239. It came from the upper reaches of the Sanpo Valley, close to Lake Mansarowar, where it was captured as a fawn, and was in its second year in 1909. It is therefore in its fifth year at the present time, and is not, as I supposed, an old animal. That the colour was the same three years ago as now may be inferred from Col. Manners-Smith's reference to it as "very light." As regards the distribution of the species, reports stated that the deer was plentiful in various places in Western Tibet, near the source of the Brahmaputra River, the hills north of Mount Kailas,

Since then the only known specimens belonging, or presumably belonging, to *C. wallichii* were menagerie animals, no confidence can be placed in their alleged localities.

Text-fig. 69.



*Cervus wallichii*.

The photograph, forwarded to Mr. Lydekker, of the specimen shown in text-fig. 67 (p. 561).

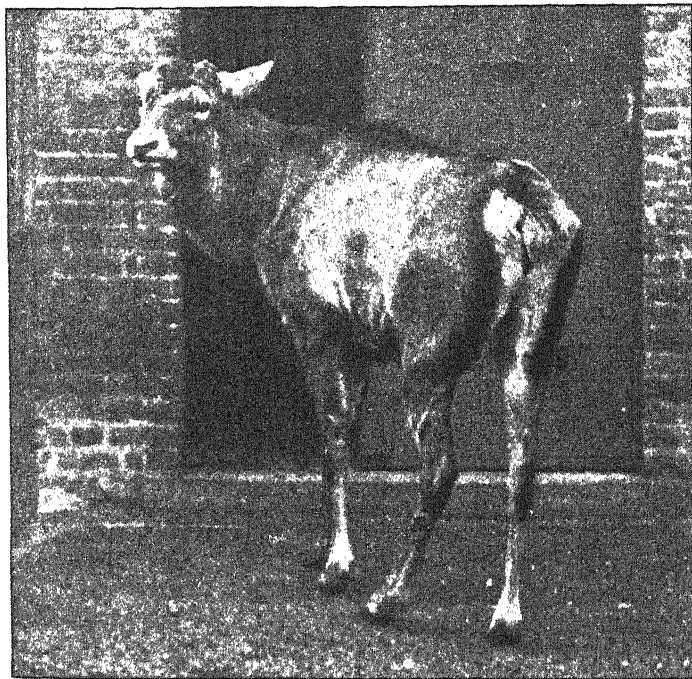
For a variety of reasons, into which it is needless to enter, *C. wallichii* has hitherto found no abiding place in the chronicles of the Cervidæ. Some authors have added its name to the synonymy of the Kashmir Stag *Cervus hanglu* (= *cashmeriensis*), others have supposed the Stag to be identical with *Cervus affinis*; others have left it as indeterminable. To settle, as far as may be, its status and affinities it is necessary to examine in some detail the characters of the two above mentioned species with which it has been confounded, and of certain other Stags belonging to the same group of the genus *Cervus*.

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and other less well-known localities being mentioned; the available evidence indicating, in Col. Manners-Smith's opinion, that the species does not cross the southern watershed of the Brahmaputra and is not found in Nepalese territory. He suggested, therefore, that the original specimen of *C. wallichii* had been brought to Muktinath from somewhere in Western Tibet round about Lake Mansarowar. It may be added that Col. Manners-Smith, apparently unaware of the discrepancies between the descriptions of *C. wallichii* and *C. affinis*, believed these two forms to be identical.

*Cervus hanglu*\*, better but wrongly known as *cashmeirianus*, is a not uncommon Stag. Moderately good figures of it have been published by Dr. P. L. Slater (Tr. Zool. Soc. vii. pl. 30, 1870), and by Mr. Lydekker (Deer of all Lands, pl. iv.), while there are several photographs in existence of specimens that have been exhibited in the Gardens or kept at Woburn. One recently

Text-fig. 70.

*Cervus hanglu.*

Specimen, living in the Gardens in March, to show the resemblance of the caudal disk to that of *C. affinis*, as described by Hodgson.

published in the 'Field,' Dec. 30, 1911, shows very clearly the shape and extent of the caudal disk characteristic of the species. The white on the inner side of the back of the thighs extends a short distance upwards above the root of the short tail, but the

\* Wagner in Schreber's Säug. iv. p. 352 (note), 1843. Various modifications of the word *cashmeirianus* are also in use; but of these *cashmeriensis* appears to be the oldest, since it was first introduced by Leith Adams in connection with a description of this species (P. Z. S. 1858, p. 529).

yellowish or dirty-white right and left moieties of this area do not meet in front of the base of that organ but are separated by a median brown band, continuous with the colour of the back; this band may or may not run along the middle of the tail itself. Thus the caudal disk is small, smaller in fact than in most Deer of the Elaphine group. Nevertheless it is very conspicuous by reason of the blackish setting formed by the adjacent hairs of the hind quarters. So far as my experience of two specimens goes, this caudal disk does not vary appreciably with the season, but remains fairly constant in extent, shape and distinctness. Nor does it alter with age, judging from the fact that in a very old animal with worn teeth, which was recently shot in the Gardens for senile decay, the disk was exactly like that of a younger animal in perfect condition now on exhibition. No doubt, however, it exhibits a certain amount of individual variation. It will thus be seen that *C. hanglu* may be at once distinguished from *C. wallichii* by its totally dissimilar caudal disk\*.

It is also darker in colour, being very decidedly brown but fading to a rather paler hue on the flanks, which are lighter than the legs, the latter being as brown as the back both externally and internally. The coat, moreover, is markedly speckled owing to the presence of a subapical pale annulus on the individual hairs.

Another very noticeable distinction between all the specimens of *C. hanglu* and the one example of *C. wallichii* that I have seen is in the colour of the hairs about the mouth. The chin and lower lip of *C. hanglu* are white and the upper lip up to the nostrils is cream or dirty-white, so that the muzzle is rather sharply contrasted in colour with the browner hue of the rest of the face. Light rings round the eyes, too, are very marked. They are not so marked in *C. wallichii* and, as has been stated, the muzzle and chin are decidedly fawn-coloured and darker than the rest of the face at least in the winter coat.

*Cervus affinis* Hodgson was based upon the skull and antlers of a Stag wrongly alleged to have come from the Sâl forests in Nepal (J. A. S. Bengal, x. pt. 2, pp. 721-724, pl., 1841). The brow tine was long, projected forwards over the face and was straight or had a sharply upturned tip. The bez was subequal and subparallel to it and also had an upturned tip, the distance between their points of origin being  $2\frac{1}{2}$  inches. Above the bez the beam reclined backwards and outwards for a short distance, then bent sharply upwards below the origin of the trez and ended in a pair of subequal terminal tines. This sharp upward bend of

\* Blyth, who believed the Kashmir Stag and *C. wallichii* to be specifically the same, explained away this difference by assuming that the caudal disk in the figure of the type of *C. wallichii* was exaggerated (J. A. S. Bengal, xxx. p. 188, 1861).

the beam, obvious both in profile and front view, is absent in the known antlers of *C. wallichii*.

In the J. A. S. Bengal, xix. p. 466, pl., 1851, Hodgson figured and described another pair of antlers sent to him by Dr. Campbell from Ding-cham, north of Sikkim. These he referred to *C. affinis*; but they only serve to illustrate the variability to which the antlers are liable.

Subsequently (J. A. S. Bengal, xx. pp. 388-394, pl. vii., 1851) Hodgson redescribed the species "from abundant supplies of the spoils [also sent by Dr. Campbell] . . . . exhibiting both sexes in various states of maturity . . . . the skulls and leg-bones being attached to the majority of the specimens." He thus had at his disposal what he described as "unusually copious and adequate material." This is an important point to remember.

The description of the antlers given in this paper agrees tolerably closely with that which he published in 1841. Certain individual variations are pointed out, and it is stated that the basal interval between the brow and bez tines varies from two to over four inches, two being the usual distance.

After remarking that the specimens were in winter coat, having been killed in February, Hodgson described the colour as "earthy brown, more or less lutescent, the head and neck being concolorous with the back; but the flanks are conspicuously paled, and the belly as conspicuously darkened . . . . the neck, though paler below than above, is not very noticeably so. But the paling of the flanks is as decidedly so as the nigrescence of the belly; the white and black forming a conspicuous contrast on these parts . . . . The limbs are paler than the back, darker than the flanks and they have an earthy-brown list down their external and anterior aspect."

Finally he said, "The tail is very short, and *the caudal disc remarkably small but conspicuous from strong contrast of colours.*" In another place he also spoke of "*the small caudal disc,*" adding "*The little tail is white, like its disc, a dark mesial line dividing the latter along the culmenal (sic) line of the tail.*"\*

This description of the small caudal disk with its median dividing dark line extending on to the tail applies tolerably accurately to the caudal disk of *C. hanglu*; and if Hodgson's published figure, bad though it be, of *C. affinis* be compared with those of the former species published by Mr. Lydekker and Dr. P. L. Selater, it will be seen that the principal differences between the two species lie in the form of the antlers and the rather larger caudal disk with narrower median line in *C. affinis*. Taking Hodgson's description as a whole, however, it amply justifies and explains Blanford's statement (Mamm. Brit. India, p. 537) that the coloration of the two species is the same, and equally discredits Mr. Lydekker's assertion that "as regards

\* The italics in this paragraph are mine.—R. I. P.

coloration [of *affinis*] accurate information is wanting" (Game Animals of India, p. 217, 1907).

The precise nature of the relationship, however, between the two species is by no means so easily and certainly settled as the literature seems to indicate.

In the British Museum there are three skins and a mounted head referred to *C. affinis*. The head and one of the skins came from Hodgson, the former being labelled "North of Bhotan," the latter "North India" and bearing the date 1857. It is not certain, so far as I know, that these specimens are part of the material that author described in 1851. Very possibly they are. If so, the head is very much faded—which is likely enough considering that it is exhibited in the gallery—because it is now a tolerably uniform sandy fawn and not "earthy brown." It is noticeable, however, that the lips and chin are fawn-coloured as in the example of *C. wallichii* in the Gardens, and not white as in *C. hanglu*. The skin, on the contrary, which has not been exhibited, agrees fairly well with Hodgson's description, being for the most part dirty brown and much darker both on the body and legs than is our specimen of *C. wallichii*. The hair, moreover, is very coarse and is of winter growth. The tail is cut away; but the white disk is not nearly so distinctly divided mesially as Hodgson's description would lead us to believe, nor as is the case in *C. hanglu*. Remnants of a brown dividing line are, however, traceable. Again, although the disk is smaller than in *C. wallichii* and is set off by a margin of darker hairs, the bases of these adjacent dark hairs are white, and the disk could be made to approach that of *C. wallichii* in size if the brown tips of these hairs were removed or deprived of pigment. But be it remembered, the bases of the hairs adjoining the croup-disk in our example of *C. wallichii* are also white, so that the disk of the latter is actually, with the hair undisturbed, as large as, or larger than, the disk in Hodgson's *affinis* with the hairs interfered with in the way supposed. In both specimens the hairs are short and crisp.

The other two skins named *C. affinis* in the British Museum belonged to the late Dr. Blanford and are labelled "Sikkim, L. Mandelli"\*. The coat is in a better state of preservation than in Hodgson's specimen above described. The general colour is greyish brown, the hairs being pale basally, brownish distally with a distinct subapical pale annulus, and a darker tip, imparting a marked speckled appearance to the coat. The rump-patch is small and white, but as in Hodgson's specimen, and in Hodgson's published figure of *C. affinis*, it spreads on to the posterior part of the croup in front of the base of the tail. In one of the specimens it is very clearly defined all round by a bordering of brown hairs unspeckled and considerably darker than the back, but with white bases. In the other the hairs bordering

\* Dr. Blanford once informed me that Mandelli's localities are untrustworthy.

the patch are only a little darker than the back and are speckled to the edge of the disk. As in Hodgson's skin the tails have been cut away, and the croup-disk has a median abbreviated irregular dark line, much more clearly defined in one skin than in the other. This disk is of about the same size as in Hodgson's specimen, although the hairs of the coat generally are longer and less close and crisped. The legs are paler, being fawn-brown down the front and on the fetlocks, and the lips and chin are also fawn, and not cream and white as in *C. hanglu*.

Reverting once more to the mounted head in the British Museum, it may be added that the left ear shows signs of the emargination of its upper border so evident in the living example of *C. wallichii*. The right ear nevertheless has a straighter upper rim. I suspect, however, that *C. affinis* has the ears shaped as in *C. wallichii*.

Putting all these facts together, it appears to me that *C. affinis* is nearly intermediate in coloration between *C. wallichii* and *C. hanglu*, especially in the general tint of the body and limbs and the size and division of the caudal disk, the most marked character in which it resembles *C. wallichii* and differs from *C. hanglu* being the fawn colour of the lips and chin.

There is evidence also that both *C. wallichii* and *C. affinis* are larger than *C. hanglu* and have longer faces\*; but judging by the standard of specific and subspecific differences usually adopted in the Cervidae, it appears to me to be doubtful whether more than subspecific importance should be granted to the differences above described between *C. wallichii*, *C. affinis*, and *C. hanglu*. It must be remembered, however, that *wallichii* is the oldest name of the three.

Exact particulars of the range of *C. affinis* are much wanted. Only two districts are mentioned by Mr. Lydekker in the table of horn-measurements in Rowland Ward's 'Records of Big Game,' 1910 (p. 38), namely, the Tibetan Frontier and the Choombi Valley; but the valleys of Bhotan near the Choombi are added under the diagnosis of the species. The Stag has also been recorded by Col. H. A. Iggulden from the Tsan-po basin, near Lhasa ('Field,' Oct. 1906, p. 736); but whether the specimens were accurately determined or not, it is impossible, without the evidence of skins, to say.

Another Stag belonging to this same group is the animal from Szechuen described by Mr. Lydekker as *C. cashmirianus macleilli* (P. Z. S. May 11, 1909, p. 588, pl. lxix.). The coat is finely speckled all over owing to the apical annulation of the hairs, as in Mandelli's skins of *C. affinis* and as in fresh-coated examples of *C. hanglu*; the prevailing colour, however, is strikingly grey, especially on the sides and legs, but the back is rather darker,

\* This difference is very noticeable between the examples of *C. hanglu* and *C. wallichii* living side by side in the Gardens.

that is to say more fawn, than the sides, and the top of the head, the face, and the nape of the neck are browner than the back. There is no mane and the neck shows signs of coat change. The legs are less distinctly speckled than the sides of the body and are darker in front than behind. The belly is whitish, as in the females of *C. affinis* described by Hodgson. Apart from the prevailing greyiness of the pelage, the most interesting features about this Stag are the brownish fawn colour of the chin and lips

Text-fig. 71.

*Cervus macneilli*.

Photograph of the plate of the type-specimen (P. Z. S. 1909, pl. lxi.).

and the coloration of the rump. The upper side of the tail is black with a narrow edging of white. On each side of the tail there is a narrow white area, which however barely surpasses the root of that organ dorsally. This white area is bordered with black, and there is a blackish-brown unspeckled croup-disk almost as extensive as the white croup-disk of *C. wallichii*.

From the distribution of this Stag, its affinities might be inferred to be rather with *C. affinis* than with *C. hanglu*; and in



spite of the lesser extent of the white on the rump, a feature in which it more resembles *C. hanglu*, this conclusion is borne out by the coloration of the chin and lips and by the shape of the ears, which are pointed and appear to have had a sinuous upper edge.

Moreover, as Mr. Lydekker records, Capt. McNeill declared the Stags of this kind that he saw in Szechuen to be nearly as large as Wapiti. Even making allowance for exaggeration in this estimate, the animals must have been of considerable size. *C. hanglu*, however, is not a large Stag, although strongly made and "cobby" in build.

Unfortunately, there is no record of the date when the type specimen of this Stag, a young hind standing, as mounted, forty inches, was shot.

Another type of this group of Stags is represented by a skin and skull kindly lent to me for identification by Mr. W. F. H. Rosenberg, F.Z.S. The animal, an adult hind, was shot by Dr. J. A. C. Smith on March 23rd, 1911, 30 miles S.E. of Tao-chou, Kansu, in China, at an altitude of 11,000 feet.

The colour is a tolerably uniform earthy brown relieved by fine close-set speckling due to a subapical pale annulus on each hair. On the sides the main shaft of the hairs is greyer and less brown than dorsally, and low down towards the belly the subapical annulus is longer, so that the general tint is markedly paler. The belly is white, but not the chest. On the neck the hairs are longer with longer apical annulus, the shaft of the hairs being browner along the nape than on the sides of the neck, so that there is an ill-defined dorsal neck-stripe as in *C. macneilli*; the front of the neck (throat) is paler than the sides; the legs are fawn-brown down the front and sides, paler behind. The forehead is brown, the face grey-brown and closely speckled; the lips and chin are fawn-brown, unspeckled and without white, and the black patch below the corner of the mouth is well marked. There is a blackish-brown unspeckled croup-disk, as in *C. macneilli*, and the hairs of this disk become gradually more and more white towards the root of the tail\*. The white on the buttocks is of the same extent approximately as in *C. macneilli*, but the tail itself is much whiter than in that animal, since it merely has a narrow median dark stripe as in most examples at all events of *C. hanglu*. The ears are long and pointed, with apparently a sinuous upper edge such as is seen in *C. wallichii*.

The following measurements in the flesh, taken by Dr. Smith, may be of future use, although at the present time they indicate nothing, because there are no corresponding measurements of other deer wherewith to compare them:—

Head and body 1745 mm. (a little under 6 feet; tail 145 mm.

\* This is probably also the case in *C. macneilli*, but I was unable to touch the mounted specimen of the animal in the British Museum.

(under 6 inches); foot (? hock to heel) 525 mm. (21 inches); ear 225 mm. (9 inches). The skin is too shrunk to make an estimate of the animal's height of any value.

The skull and teeth show that the specimen was a full-grown, but not old, hind. Its basal length from the notch between the condyles to the tip of the premaxillæ is  $13\frac{3}{4}$  inches (about 344 mm.); and the length from the anterior edge of the orbit to the tip of the premaxilla about 9 inches (= 225 mm.), and the width across the orbits  $6\frac{1}{4}$  inches (= 156 mm.).

On comparing these dimensions with those recorded by Blanford for *C. hanglu* and *C. affinis*, it would appear that this Kansu Stag is somewhere about the size of the former. For example, he quotes the length of the Hangul (probably of males) as from 7 to  $7\frac{1}{2}$  feet and the length of a skull of this sex as just over 15 inches. Probably the basal length of the latter would be about  $14\frac{3}{4}$  inches.

The smaller of two skulls of *C. affinis* had a basal length of  $16\frac{1}{4}$  inches and a width across the orbits of about  $7\frac{1}{3}$  inches. Thus, allowing for the fact that the Kansu specimen is an adult female, it may be inferred that the males are about as large as those of *C. hanglu* and considerably smaller than those of *C. affinis*.

The description given above of the colour of this Stag agrees in a general way tolerably closely with that of the examples of *C. affinis* that Hodgson had in his hands, and it is important to remember the close correspondence in date, Hodgson's specimens having been killed in February and the Kansu specimen in March; and since deer of the Elaphine group moult in April and May, it is evident that the examples in question were still carrying their winter coats. In their generally dark earthy brown coloration, both differ markedly from the living example of *C. wallichii* in March.

The coloration of the Kansu specimen, however, is not identical with that of *C. affinis*. I do not think it safe on the evidence of one skin to trust much to the greater uniformity of the colour of the body as shown by the absence of a distinct darkening of the back and "lutescence" of the sides to which Hodgson refers in *C. affinis*, but the large size of the dark croup-patch and the smaller extent of white at the base of the tail are probably more dependable. It is in both these particulars especially that the Kansu stag resembles the Szechuen stag *C. macneilli*. Since, however, it differs from the latter in general coloration and in the greater amount of white in the tail; from *C. affinis* in having no white above the root of the tail and a larger dark area on the croup; from *C. wallichii* in having no white on the croup at all, except such as is concealed by the overlying black ends to the hairs; and from *C. hanglu* in the dark colour of the chin and upper lip, the Kansu stag seems to deserve a name; and I propose to call it *C. KANSUENSIS*.

The following analytical key to the species above discussed represents my views as to their probable affinities :—

- a. Chin and lower lip white, muzzle pale fawn, markedly lighter than the rest of the face; ears bluntly pointed and with straight upper rim; no white on croup above root of tail ... *hanglu* Wagn.
- a'. Chin fawn or brown, muzzle brownish fawn with at most a little white on the lip in front; ears long and pointed with sinuous upper edge (♀ in *affinis*).
- b. White on back of thighs not spreading on to croup above root of tail; tail dark down centre; a large blackish-brown croup-patch reaching nearly or quite to the summit of the croup.
- c. Prevailing colour grey, rather darker on the back and still darker on the head; practically the whole of the upper side of the tail black ..... *macneilli* Lydd.
- c'. Prevailing colour (March) brown; upper side of tail with an irregular median dark stripe ..... *kansuensis*, nov.
- b'. White on back of thighs spreading upwards above the root of the tail and encroaching more or less on the croup; dark patch on croup smaller or absent.
- d. White area above the tail comparatively small with a more or less distinct median dark longitudinal stripe; prevailing colour (February) earthy brown, paler laterally ..... *affinis* Hodgs.
- d'. White area above tail very large, reaching summit of croup and undivided by dark line; prevailing colour (March) pale fawn-brown ..... *wallichii* Cuv.

In selecting the colour of the chin and muzzle as the character for eliminating *C. hanglu* from the rest of the species, I am not unmindful of the fact that Cuvier wrote of *C. wallichii* "comme l'ordinaire, le tour de l'œil, celui de la bouche, sont plus pâles, et il y a du blanc sous la mâchoire et une tache noire sous l'angle des lèvres." These words may suggest that the muzzle and chin were coloured as in *C. hanglu*; but the coloured plate of *C. wallichii*, from which the description was taken, does not bear out this supposition nor does it quite justify Cuvier's phraseology, for the lips and chin are washed with the same yellowish tint as that of the rest of the body.

If the caudal disk were taken as the primary basis for the classification of the species, they would be grouped as follows:—*C. macneilli* + *C. kansuensis*; *C. hanglu* + *C. affinis*; *C. wallichii*. I prefer on the whole to regard these forms as species rather than subspecies because we have at present no proof that they intergrade, and the differences between them are perhaps greater than those between the various races of Wapiti (*Cervus canadensis*) and Red Deer (*Cervus elaphus*). As a group they resemble the Wapiti and differ from the Red Deer in the shortness of their tails.

The only other Stag which should perhaps come into the same category, judging from the shortness of the tail, the size of the caudal disk, and the shape of the ears, is the Tibetan species commonly known as *C. albirostris* which Blanford described as *C. thoroldi* (P. Z. S. 1893, p. 444). Judging from the mounted specimen of this stag in the British Museum the coloured figures of this species published by Blanford and by Mr. Lydekker

('Deer of all Lands,' pl. v.) have the yellow caudal disk too large and extending too high up the croup, and the ears, which are really very long and pointed, with the upper edge sinuous, represented as much too short and blunt. In the whiteness of the chin and muzzle this species goes a stage beyond *C. hanglu*; but of course the stag differs from those discussed in this paper by the reversal of the hairs along the spine between the croup and withers and, so far as is known, by the absence of the bez tine.

In the above given table no use has been made of the antlers as distinguishing features. These vary so much with age and from a variety of unknown causes that I am convinced too much confidence is placed in them in most systematic treatises on Deer\*. At the same time it may be useful to bear in mind that the recorded antlers of *C. wallichii* appear to differ from average antlers of *C. hanglu* and *C. affinis* in the basal juxtaposition and marked distal divergence between the brow and bez tines, and at least from those of *C. affinis* in the comparative straightness of the beam which lacks the sharp upward curvature of its distal half. It will be highly interesting to see if the example of *C. wallichii* now living in the Gardens grows, under the changed conditions of its existence, antlers resembling those that it shed on its journey from India. This and the colour of its summer coat I hope to have the chance of recording later on.

As regards the stature of the Deer described above, Blanford gave the height of *C. hanglu* as ranging from 48 to 52 inches. The example of this species now in the Gardens is barely 48 inches. *C. affinis*, according to Hodgson, stands from 54 to 60 inches and thus rivals a Wapiti in stature. A small Canadian stag Wapiti now in the Gardens is about 56 inches, and an example of *C. xanthopygus* 58 inches. But since Hodgson's measurements of *C. affinis* were taken from dried skins, his estimate must have been largely guess-work and probably erred on the side of exaggeration than otherwise. Blanford, or the authorities from whom his information was derived, measured in all probability freshly killed specimens of *C. hanglu*; and since dead animals give higher stature-measurements than living ones, exaggeration in connection with this species must also be allowed for.

Our living example of *C. wallichii* is as nearly as possible 51 inches, and is manifestly much smaller than any stag of the Wapiti group, whether American or Asiatic, that I have seen. It is, however, exactly the height assigned by Hardwicke to the typical example of this species that was exhibited in the menagerie at Barrackpore.

\* I can see no reason for adopting Mr. Lydekker's suggestion ('Field,' May 11th, 1912) that the Stag he described from a pair of shed antlers picked up in Szechuen as *Cervus canadensis wardi* (P. Z. S. 1910, pp. 987-989) is identical with *Cervus wallichii*.

31. Contributions to the Anatomy and Systematic Arrangement of the Cestoidea. By FRANK E. BEDDARD, M.A., D.Sc., F.R.S., F.Z.S., Prosector to the Society.

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(Text-figures 72-83.)

IV. ON A SPECIES OF *INERMICAPSIFER* FROM THE HYRAX, AND ON THE GENERA *ZSCHOKKEELLA*, *THYSANOTÆNIA*, AND *HYRACOTÆNIA*.

INDEX.

Systematic:	Page
<i>Inermicapsifer capensis</i> , sp. n. ....	593
<i>Hyracotænia</i> , gen. n. ....	604
<i>H. capensis</i> , sp. n. ....	604
<i>H. hyracis</i> , sp. n. ....	605
<i>Thysanotænia</i> (corrections and additions) .....	606
<i>Zschokkeella</i> .....	607

I obtained during the month of October 1911 a large number of fair-sized unarmed tapeworms from the gut and from the gall-bladder of an example of *Procavia capensis*, and I referred them provisionally to the genus *Zschokkeella* of Fuhrmann\* in my Report to the Prosectorial Committee, in spite of the fact that the type species of that genus is a parasite of the Guinea-Fowl *Numida ptilorhyncha*. I now refer them partly to the more recently instituted genus *Inermicapsifer*†, the affinities of which with *Zschokkeella* and my own genus *Thysanotænia*, I shall deal with in the present communication. The author of the genus *Inermicapsifer*—and in the paper referred to—assigns to that genus with certainty or with more or less doubt eight species. I shall compare these individually with the species I have found myself. Dr. Janicki is certainly justified in saying that “the fact is of interest that the genus *Inermicapsifer* is parasitic in *Procavia* with several nearly related species.”

From the intestine of *Procavia capensis* I have gathered specimens of several distinct species, of which one was much more abundantly represented than the others. The more abundant species is represented in the accompanying text-figure (text-fig. 72).

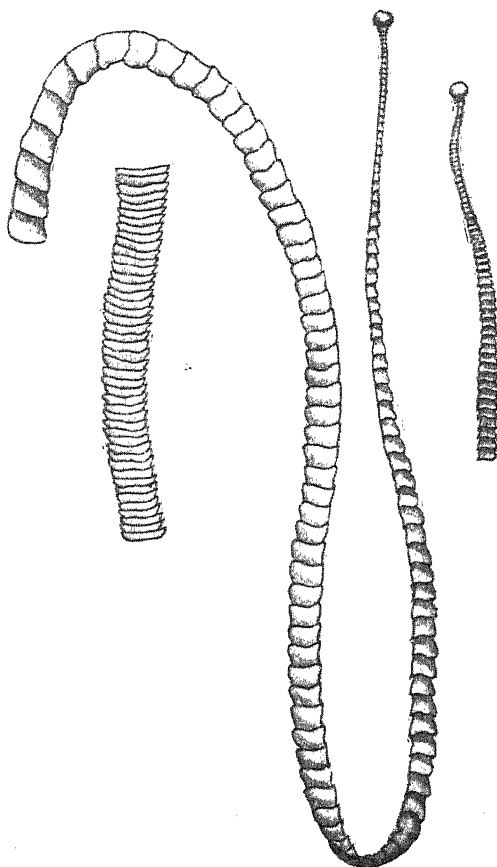
It is a long and rather slender worm, about 95 mm. in length and of 2 mm. greatest diameter. There are fully 200 proglottids in this example. The head is very conspicuous and half as wide again as the part of the strobila which ensues. Anteriorly the worm is more slender, of less diameter, than it is posteriorly; the increase is gradual, there being no sharp demarcation. The body of these worms has a great tendency in specimens preserved

\* Centralbl. f. Parasit. etc. Bd. xxii. 1902.

† Janicki, “Die Cestoden aus *Procavia*,” in Schultze’s Zool. Ergebn. Forschungsreise in Südafrika, Jena Denkschr. med. Ges. xvi., 1910.

in alcohol to contract upwards or downwards, thus forming a hollow or convex surface as the case may be. The characters already given allow us to separate the present species from *I. hyracis*\*, in which the scolex is not of greater diameter than the ensuing region of the strobila, and from *I. settii*†, where the total number of proglottids is very small (*i. e.* 30-70).

Text-fig. 72.



A nearly complete example and two fragments of *Inermicapsifer capensis*.

× 2.

I do not at this stage of my description attempt to differentiate between this species and the others dealt with in Janicki's

\* Janicki, *loc. cit.* pl. xii. fig. 1.

† Janicki, *loc. cit.* pl. xii. fig. 10.

monograph, since there is some little variation in the characters of the numerous examples which I have to consider here, which variations do not militate against the exclusion of *I. hyracis* and *I. settii*, though they render difficult the distinguishing of my species from some of the others referred to by Janicki. Thus two examples measured only 68 mm. and 75 mm. respectively, and one of them was quite 3 mm. in diameter at the widest part. The segments were never longer than broad, except perhaps a trifle longer in the thin anterior region of the body. They varied somewhat in relative dimensions, as is the case\* with those of *I. hyracis*. Occasionally the unilateral genital pores were very visible on slight papillæ near to the hinder end of segments.

The scolex is quite unarmed and conspicuous by its size, as already mentioned. It is usually more or less globular in form, with a slightly prominent and somewhat pointed apex, as is shown in Janicki's figure of *I. settii*†, and which is, of course, the rostellar region. Occasionally, however, this apical region does not protrude, but is represented by a depression on the surface. The scolex is, moreover, sometimes flattened in its entirety from above downwards, and presents a mushroom-like appearance, the edges of the disc projecting round the neck, which thus presents the appearance of the stalk of the mushroom.

Longitudinal sections through the scolex confirm the total absence of hooks or of any trace of a rostellum, save the slight projection already mentioned. Nor could I detect anything peculiar in the structure of the suckers, which, according to Janicki and others, are remarkable for a funnel-like ingrowth leading to the actual sucker, which thus lies at the bottom of a depression. It is true that in the present species, as in many tapeworms of the group Tetracotylea which I have examined, the sucker does not lie externally on the scolex, but is covered by an outer layer of body-wall which is only interrupted at the orifice of the sucker. The free edge of this, when depressed towards the interior of the sucker, is doubtless funnel-shaped and would give rise to the appearances represented by Janicki. Perhaps, however, there is some divergence from the normal condition of the suckers in the members of the genus referred to by him, which I certainly have not found in the species with which I am at present concerned. The direction of the suckers seems to me to vary somewhat; generally they are lateral, but sometimes with a forward inclination.

It has been already observed that in this genus water-vessels of unusual width extend far into the head. Such are figured by Janicki, and referred to by Pagenstecher‡ (quoted by Janicki §) as "einen mit Ringmuskeln umspinnenden Wasserbehälter." In

\* Janicki, *loc. cit.* pl. xii. figs. 2-5.

† *Loc. cit.* pl. xii. fig. 10.

‡ Zeitschr. f. wiss. Zool. Bd. xxx. 1878.

§ *Loc. cit.* p. 389.

the present species a good deal of the head lying between the suckers is occupied by the coils of water-tubes, which approach very nearly to the external surface at the apex of the head. These tubes are not in any way irregularly dilated, but their diameter throughout is rather greater than that of the tubes in the immediately following neck-region of the body. Janicki is not disposed to lay great weight upon the absence or presence of a neck in these tapeworms. In the present form the strobilisations begin very close to the head, which is supported by a segment broadening towards the head, which may be regarded as the neck. In the accompanying text-figure (text-fig. 72) will be seen the general characters of the strobila of this worm.

The body-wall of the worm is relatively thick, but here the cortical layer is not so definitely marked off from the medullary parenchyma as is so often the case. The absence of a strong delimitation is due to the very feeble development of the transverse musculature, which is generally hardly, or not at all, recognisable in transverse sections. Another reason which renders the two layers more uniform in this species than in my *Thysanotenia gambiana* and in the species of *Hyracotenia* described in the present paper, is that there are stout muscular fibres in the medullary parenchyma comparable in thickness to the longitudinal muscular fibres of the cortical layer.

*Water Vascular Tubes.*—These tubes are, as usual, two on each side. They lie, as a rule, almost parallel with each other, the smaller dorsal tube having, however, an inclination to the dorsal side which is more or less pronounced as the case may be. The more medianly situate ventral tube is the wider, but the difference between the two is not perhaps quite so well-marked as in *Thysanotenia gambiana*. The two vessels are not united across the proglottids by a regular series of transverse vessels, one to each proglottid, but, as in other species of this genus and in *Thysanotenia gambiana*, are united by a network of tubes found all over the segments. I did not follow out into any detail the precise arrangement of the branching connecting-tubes.

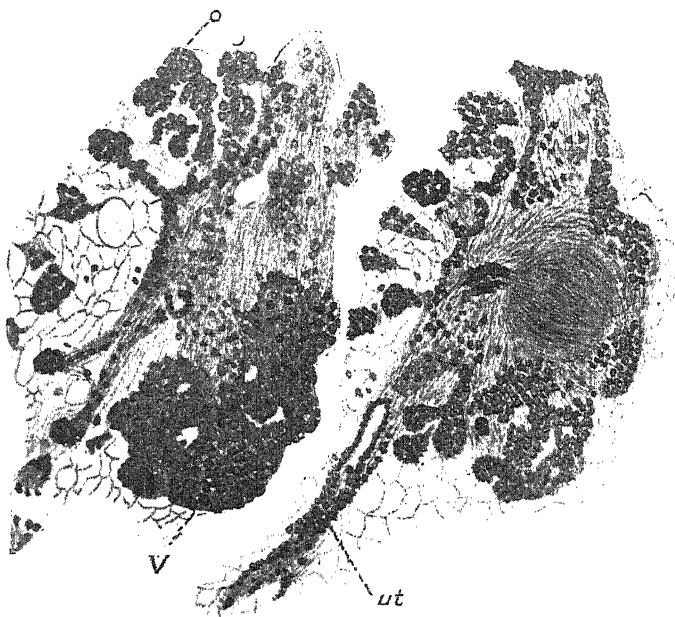
The ovary, when fully mature, appears to be definitely a single body lying anterior to and in contact with the vitelline gland. The latter lies on a level with the group of testes of the pore side. The ovary lies, when less fully mature, entirely to the median side of the two water vascular tubes. Later on, it appears to extend somewhat and is larger actually, and considerably larger relatively, than I found it to be in *Thysanotenia gambiana*. The ovary is clearly also larger in the present species than in *Inermicapsifer hyracis*, according to Janicki's figures. In the later stages of the ovary, when it is gorged with ripe eggs and these are beginning to spread through the proglottid, a peculiarity of structure, perfectly plain in earlier stages, is not obvious. One such example, representing the ovaries, is represented in text-figs. 73 and 74. It will be there seen that the ovary really consists of clumps of ripe and unripe eggs situated at the ends of



stalk-like processes of the oviduct, from which they radiate out. There is some evidence that these are probably hollow outgrowths of the oviduct, the main stem of which is continued on to form the rudimentary (at any rate, short) uterus. There is also some evidence that these outgrowths of the oviducal canal form here and there anastomoses with each other. In the fully mature ovary the ripe eggs are seen to be in groups surrounded by a thin wall and with empty spaces surrounding eggs or groups of eggs.

Text-fig. 73.

Text-fig. 74.



Text-fig. 73.—Ovary and vitelline gland of *Inermicapsifer capensis* in section.  
o. Ovary. V. Vitelline gland.

The masses of ova are seen at the end of stalk-like processes.

Text-fig. 74.—Another section through the same ovary to show the rudimentary uterus (ut.).

It seems to me that we have here a later stage of the tubes communicating with the oviduct. From this point of view the ovary would appear to be a compound body, in reality consisting of many ovaries; the indications of a network among these ducts is particularly interesting in view of the network formed by the testicular ducts, and brings the male and female organs into closer agreement.

The *vagina* opens on the exterior behind the aperture of the cirrus sac and immediately contiguous to it. As will be mentioned in describing the cirrus sac there is no common cloaca. The direction of the tube from its opening into the receptaculum seminis is obliquely backward, the external pore lying at the side of the segment posteriorly. The terminal portion of the *vagina*, the length of which is not far from equal to that of the cirrus sac, is somewhat dilated and with a wider lumen; it is plainly ciliated. The whole of the *vagina* is very muscular, the muscular layer being as thick as that of the cirrus sac. The lining epithelium is deeply stained. The course of the *vagina* is very straight until it bends somewhat at its entrance into the large receptaculum seminis. The latter is bent round the outermost of the two longitudinal water vessels. From its opposite end arises the wide common duct, which after a short course divides into the posterior vitelline duct and the anterior oviduct. The two latter are in the same straight line.

A closer examination, however, of the long muscular *vagina* shows that it is really divisible into two regions. These are inequized, the larger section being that which is nearer to the external pore. This section has a much wider lumen than the ensuing section, which opens into the wide and thin-walled oviduct. The latter has a narrow thread-like lumen, but still thick and muscular walls. It is not so long as the distal region of the *vagina*. This part corresponds to the very short and suddenly abbreviated part of the *vagina* in *Thysanotenia gambiana*; but is obviously very much more developed. It is not in the same straight line as the wider distal section of the *vagina*, but bends back to meet the forwardly running oviduct. This division of the *vagina* appears to be very characteristic of the present species.

At the time that I was preparing my account of the anatomy of the two species of my genus *Thysanotenia* I was not acquainted with Janicki's memoir upon his genus *Inermicapsifer*, and therefore laid no stress upon some structural features which are of importance in comparing these forms. I have therefore carefully re-examined my sections of *Thysanotenia gambiana*, and made in addition several series of fresh sections, in order the better to accomplish this comparison. By these means I am in a position to make a few corrections in, and additions to, my earlier account.

I find that account, however, to be correct in all essentials, excepting with regard to the presence of a vesicula seminalis in the neighbourhood of the ovary. This was doubtfully asserted, however, and I now find that the structure in question is really a part of the dilated and thin-walled oviduct, which runs straight, as I have said, from the thick-walled region near to the external pore and gradually increases somewhat in width as it approaches the ovary. I confirm my account of the variability in the lateral extension of the ovary and vitelline gland, which

are sometimes restricted in their extent to the space lying between the dorsal and ventral vessels. In incompletely mature proglottids this restriction appeared to be (at least usually) the case, the gonadial tissue not extending outside or inside of the two excretory tubes. I should also emphasize the fact that the ovary and vitelline glands are, at least for part of their extent, situated side by side. That is to say, the vitelline gland is not wholly behind the ovary. In young proglottids the general lie of the female gonad seemed to me to be rather oblique dorso-ventrally, in accordance with the fact that the duct passes to the exterior ventrally of the dorsal excretory vessel and that the two excretory vessels lie in a nearly parallel plane.

I have also a new fact of some little importance to add. I have described the uterus in the sexually mature segments as being a tubular structure running across the segments. I have in younger specimens discovered the rudimentary uterus, which consists of a solid chord of closely packed cells which enclose no lumen. This is connected with the gonad tissue lying between the two excretory tubes and passes towards, but not far towards, the middle line of the body above the larger ventral excretory tube, but below the sperm-duct. The rudimentary uterus ends in a club-shaped blind extremity.

My former account of the testes of *Thysanotenia gambiana* is confirmed by the examination of fresh material. I have, however, two points to add: the first is that while the testes are practically grouped as there stated into two groups, there are, nevertheless, a very few testes lying between the two ventral excretory tubes, and thus really constituting a bridge between the two separate masses, and bringing the arrangement of the testes more into line with that of the second species of the genus *Thysanotenia* described in the paper referred to. These, however, are indeed few; I counted but three in a single proglottid. The general statement with regard to the testes remains, therefore, unaffected. Moreover, each testis is rounded or oval in form, but I could not find the distinctly pear-shaped outline that I describe in the species of *Inermicapsifer* dealt with in the present paper. I should, furthermore, add to my former account the fact that the testes are mature before the ovaries, and that in segments where the ovary is still immature the vagina, as well as the vas deferens, is filled with sperm. The sperm-duct is coiled and the coil lies principally between the nerve-chord and the dorsal excretory tube, extending to a short distance mediad of the latter. The coils have some regularity and lie dorso-ventrally and parallel. I have found granular tissue accompanying the sperm-duct. Cells lay here and there between the coils, sometimes in numbers.

The testes of the worm from the Hyrax are very distinctly arranged in two sets in each proglottid. The great bulk of these organs are on the side furthest away from the external pore. I did not find a few scattered testes uniting these two groups such as occur

in *Thysanotenia gambiana*. The point of difference, however, is not a large one, since in other species of the present genus there is no differentiation of the testes into two masses, but they form a continuous mass reaching from side to side of the proglottid. In the case of the group of testes on the pore side, they lie to the pore side of the ovary and vitelline gland. These testes were very conspicuously pear-shaped, the duct naturally arising from the pointed end. In the case of the testes on the pore side, at any rate, the narrower end faced forwards in the segment. In the case of each group the testes are closely packed together. They are restricted to the medullary part of the parenchyma. The efferent sperm-ducts from the testes which lie away from the pore side form a widish trunk which breaks off and forms a slight rete mirabile not so marked as in the species next to be described. This opens evidently by one thick tube into the large vesicula seminalis lying close to the ovary and to the receptaculum seminis.

The *cirrus sac* is not conspicuously large, and it lies close to the lateral margin of each proglottid and thus well within the cortical parenchyma. Its position is oblique, the end of the sac being anterior to its aperture on to the exterior, and is thus better shown in horizontal than transverse sections of the proglottids. The general outline of the cirrus sac, when displayed in such sections, is, like that of many other species (e. g. *Otiditœnia eupodotidis* \*), flask-shaped, there being a narrower proximal neck and a wider distal region. It lies parallel to the vagina and very close to it, but in a different plane, so that a single horizontal section does not display both tubes lying side by side. Such a section, however, does show the extreme terminal part including the external orifice of both cirrus sac and vagina; and it will be seen that they lie accurately side by side, the male pore being, of course, anterior to the female pore. Such a section also shows very plainly that there is no trace of a cloaca genitalis; the two pores are upon the surface of the body upon a slightly raised papilla of not very great dimensions. The papilla which bears the two orifices is clearly of less importance than that which characterises the two worms for which I have recently formed the genus *Thysanotœnia* †. On a re-examination of my sections of the species *Thysanotœnia lemuris* I find that in that species, as well as in that which forms the subject of the present communication, there is no sinus genitalis, but that both cirrus sac and vagina open side by side on the summit of the papilla. The case is otherwise with *Thysanotœnia gambiana*, where there is a distinct though not very large sinus or cloaca genitalis. There are also corresponding differences in the vagina and cirrus sac of the latter, which I shall deal with after describing the arrangements found in the Anoplocephalid from the Hyrax.

The cirrus sac has a thickish muscular coat which does not become at all markedly thicker in the "neck" region. In

\* P. Z. S. 1912, p. 206, text-fig. 27.

† P. Z. S. 1911, p. 1002.

longitudinal sections it appears that the fibres constituting together this muscular wall run more or less along its longer axis. It will be observed that in both of these characters the cirrus sac of this species differs from that of a genus recently described by myself as *Otiditænia*\*, and, moreover, the cirrus sac is very much larger in the latter genus. The cirrus itself is very inconspicuous and occupies only the neck region of the sac; it is thus necessarily very short. It is distinguishable from the sperm-duct by reason of the fact that it is very darkly stained with both carmine and hæmatoxylin. Between the cirrus and the muscular walls of that part of the cirrus sac in which it lies is a great accumulation of nuclei, which belong, as I presume, to slender muscular fibres concerned with the retraction of the cirrus.

As in other species the cirrus sac, where it swells out into the rounded flask-like body, is filled with a delicate packing tissue with abundant nuclei. Through this passes the sperm-duct in two or three coils. The delicate sperm-duct takes up but little stain and is thus very distinct from the cirrus. I found this condition of the sperm-duct to exist in a segment *posterior* to others in which the sperm-duct had undergone even further modification. In the latter segments the sperm-duct lying within the cirrus sac is dilated to form a vesicula seminalis. This dilated duct is also coiled; but the two or at most three pieces seen in an individual section completely fill the lumen of the cirrus sac, with the exception of dividing lines filled with nuclei belonging to the internal tissue of the cirrus sac. The fact that an unaltered sperm-duct may lie behind one which is converted into a vesicula seminalis is important.

It is clear that, on the whole, the cirrus sac of this worm is more like that of the two species which I have referred to a new genus, *Thysanotænia*, than it is to that of, for example, *Otiditænia*† or *Anoplotaenia*‡. It differs, however, in details from the cirrus sac of both of the two species which I have temporarily placed in the genus *Thysanotænia*. In the concluding part of the present communication it will be necessary to go fully into the systematic position of this worm and to compare it especially with the two species of the genus *Thysanotænia*. It will be therefore convenient at the present moment to compare the cirrus sac in these different forms. They agree generally in the absence of a distal region, which I have termed penis in *Anoplotaenia*, the cirrus being rod-like up to its free extremity and not lying at the bottom of an invaginated part of the cloaca genitalis. Again, in all three species the general form is the same, and the muscular layer runs along the longer diameter of the sac and is not specially thickened at the "neck" end. These features exhaust the general resemblances between the

\* P. Z. S. 1912, p. 206, text-fig. 27.

† P. Z. S. 1912, p. 194.

‡ P. Z. S. 1911, p. 1015, text-fig. 215.

cirrus sacs of the three tapeworms. That of *Thysanotænia lemuris* differs from the other two by its larger size, the cirrus sac in the two remaining species being of about the same size. The cirrus sac of *Thysanotænia lemuris* is, indeed, fully twice the size that it is in the two other species. In the species which forms the subject of the present communication the cirrus is very small and limited to the neck part of the cirrus sac, than which it is no longer. The same characteristics apply to *Thysanotænia lemuris*, only that as the cirrus sac itself is larger, the cirrus also is larger than that of the species with which I compare it. In both of these species the rest of the cirrus sac is filled with the sperm-duct, which is, in both, dilated to form a vesicula seminalis; but in *Thysanotænia lemuris* the dilatation fills the whole sac, while in the other species it is coiled and thus fills the sac in a different way. In the species *Thysanotænia gambiana* there is no such conspicuous vesicula seminalis, but just after the entry of the sperm-duct into the cirrus sac it is dilated for a short space. On the whole, it appears that the cirrus sac of the present species is more like that of *Thysanotænia lemuris* than of *Th. gambiana*.

One of the principal differences which this species shows from *Thysanotænia gambiana* is in the character of the uterus. As I have already mentioned in the present paper, as well as in my memoir dealing with that species, the uterus is very plain, first as a solid cord and then a narrow tube with an obvious lumen. An examination of a large number of sections of the species of *Inermicapsifer* described here has shown nothing exactly like the uterus of *Thysanotænia gambiana*. Nor can I reconcile what I have seen with the figures of Janicki's illustration of the uterus of *Inermicapsifer hyracis*. In the latter species the uterus is figured \* in horizontal sections through the ripe proglottid as an irregularly shaped sac with numerous projections and outpushings of its lumen—as, for example, in the genus *Tetrabothrium* †. It is shown, however ‡, to commence as a sinuous tubular structure, which appears to me to resemble very much the uterus as I have described it in *Thysanotænia gambiana*. Earlier still than this a solid cord of cells issues from the generative mass which again would appear to be exactly comparable to what I have seen in *Thysanotænia gambiana*. Janicki, however, comments upon the remarkable fact that the formation of a lumen in this cord begins, not where it would be expected to begin, at the ovarian end, but towards the middle of the segment. It is here, moreover, that in *Thysanotænia gambiana* the solid cord of cells, which subsequently becomes the hollow uterus, widens out into a club-shaped extremity; but I am unable to confirm or differ from Janicki in fixing the point at which the uterus begins to be hollowed out to be coincident with this club-shaped extremity. It seems, however, to be very likely.

\* *Loc. cit.* pl. xii. fig. 13.

† Spätlich, in Zool. Jahrb. Bd. 28 (1909).

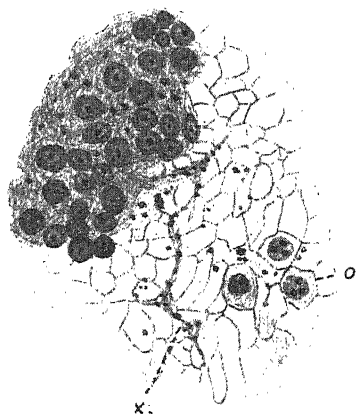
‡ *Loc. cit.* pl. xii. fig. 17, ut.

The examination of more than one series of sections has shown me that, in the species of *Inermicapsifer* which forms the subject of the present communication, the commencement of the formation of the uterus is in many respects different from that of *Inermicapsifer hyracis* as described by Janicki and of *Thysanotenia gambiana* as described by myself. The earliest stages that I have observed are perhaps best seen in horizontal sections, though I have also observed them in transverse sections. In horizontal sections, such as is represented in text-fig. 74, the ovary lies in the middle of the segment from before behind and extends some way towards the middle of the segment from right to left. The oviduct with its numerous branches, which has been

Text-fig. 75.



Text-fig. 76.



Text-fig. 75.—A portion of the medullary parenchyma of *Inermicapsifer capensis*, showing centrally a condensation of tissue which is connected with the rudimentary uterus.

Text-fig. 76.—A portion of the ovary of the same species with eggs (o.) detached from the ovary and lying in the parenchyma, and a portion of the network of tissue (x.) which may possibly represent the uterus.

already described, is seen to be prolonged into an extension not distinguishable from it, which runs for a little way into the medullary parenchyma towards the median point of the proglottid. It is quite short, and ends more or less abruptly in a strand of condensed parenchymal tissue, which is apt to be branched, sending out shorter strands of a similar appearance in an oblique direction. Some of these ceased after a short course. In neighbouring regions of the proglottid (text-figs. 75 and 76) there were patches or rather strand-like parts of the medullary parenchyma

exactly similar to those which have been described as continuous with the prolonged oviduct, but not always continuous with it. They would seem to be produced independently of the generative ducts. A network arrangement often characterised these regions of the medullary parenchyma. This condition of the uterus characterised proglottids in the same stage of evolution as those which in *Thysanotenia gambiana* possessed an uterus with a distinct lumen. But if we are to compare them with earlier proglottids in *Thysanotenia*, then it must be remarked that in the present species of *Inermicapsifer* there is no such regular band of nuclei, marking out the future uterus, as exists in the former worm. The appearance is, in fact, totally different. In *Inermicapsifer* the suggestion is merely of a crowding together in a quite irregular fashion and a local multiplication of the nuclei of the cells of the medullary parenchyma. In *Thysanotenia* the nuclei are in orderly arrangement and regular sequence, obviously belonging to an organ which, as already pointed out, swells at its medianly situate end into an oval region of greater diameter. In *Thysanotenia* we have obviously a regular outgrowth of the generative system; in my species of *Inermicapsifer* what would appear to be a condensation of parenchymal tissue in contact with and continuing on a very short, and in this species hollow, outgrowth of the generative duct. I am not clear whether the species described by Janicki agrees most nearly with the species described in the present paper or with *Thysanotenia gambiana*. I am disposed to think that the branched strand in which the slightly prolonged oviduct ends in this *Inermicapsifer* is not the homologue of the solid mass of cells in *Thysanotenia gambiana*, which afterwards becomes hollowed out to form the uterus of that worm; in this case *Inermicapsifer hyracis* agrees more closely with *Thysanotenia gambiana* than with the species described here.

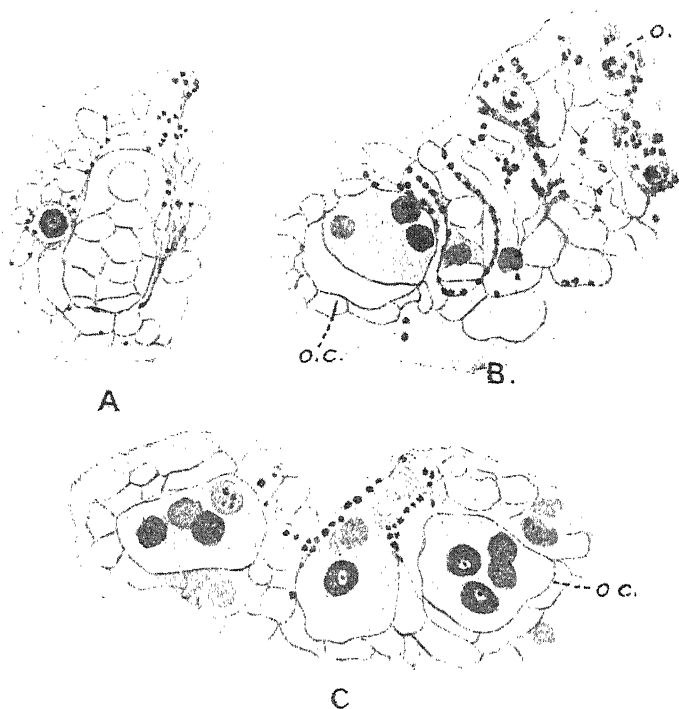
It might possibly be held that this network, which permeates the segment when seen in horizontal section, is merely a stage subsequent to that figured by Janicki in a proglottid of somewhere near the same stage of maturity as that which I am now considering in the species of *Inermicapsifer* studied by myself—that the lumen had, in fact, existed and had disappeared. That this is not the case is clear from the fact that in this stage there were not any ova contained in the meshwork, and in fact no ripe ova anywhere outside of the ovary. The meshwork formed by condensation of the parenchyma, in fact, precedes the extrusion of ova from the ovary. Still, it may represent the imperfect remains of a retiform uterus such as is characteristic of the genus *Dipylidium* or, better perhaps, in relation to the present genus, the Anoplocephalid genus *Andrya*.

I have also been able to approach the question of the identity or non-identity of the cavity in which the eggs lie with the cavity of the uterus from another side. Text-fig. 77 represents portions of horizontal sections through a proglottid in which the



eggs are leaving the ovary to be scattered through the medullary parenchyma, though in this particular stage the whole parenchyma is not filled with eggs as it is later and at the end when the whole medullary region is crammed with the paruterine organs. As will be seen by a reference to the figures cited, the eggs lie partly in round or oval cavities which might well be

Text-fig. 77.



Three sections through the medullary tissue in the neighbourhood of the ovary of *Inermicapsifer capensis*.

In **A** a single ovum is shown to the left. In the centre is an oval area with strongly marked walls, but filled with the ordinary medullary tissue.

**B** shows eggs (*o.*) lying each in a single vesicle of the medullary tissue and three eggs lying in a cavity (*o.c.*).

**C.** Three of the cavities (*o.c.*) containing eggs and also showing remains of the medullary tissue which is shown unaltered in **A**.

thought to be uterine cavities were no further information forthcoming. I believe, however, that these cavities are not remnants of a uterus, as is held by Janicki to be the case with apparently similar cavities in *Inermicapsifer hyracis*. A close

examination of the cavities seems to show that they are lined by a flattened epithelium, of which the nuclei are apparent and are represented in the figure, and there is a slight accentuation of the wall of the cavity, which is merely, as I think, the portion of the parenchymatous network which abuts upon the cavity and is not a special layer distinct from that; in this case the apparent lining epithelium should be regarded merely as the nuclei belonging to this part of the parenchymatous network. I believe this to be the real explanation; for when we look carefully into the cavity itself, in which eggs lie in various numbers, there is nearly always, if not quite always, some granular detritus to be seen and which is shown in the figures referred to. This formless detritus (as it often, but not always, is) might, of course, be interpreted as simply coagulated fluid which it would not be surprising to meet with in the interior of a uterus were this system of cavities the remains of a uterus. But, as will be seen, this detritus is susceptible of another explanation; it is, as I think, the remains of the delicate parenchymal network originally present, as is shown in text-fig. 77 A, in these regions of the parenchyma set apart for the development of the eggs. The figure referred to shows plainly an area oval in section and with a slightly accentuated wall, marking it off from the surrounding tissue, which is filled with parenchyma network, but does not as yet contain any eggs. If my contention is right, then it must follow that the space containing developing eggs is at least not always to be referred to a uterus. Nor is it in the least against this view that it is possible to meet with these circular spaces in which nothing is apparent but eggs—that is to say, no remains of the originally present parenchymal network, for this may have completely disappeared. I would furthermore point out that the position of the eggs in the nearly empty cavity shown in text-fig. 77 B suggests that they have only just forced themselves into the cavity.

I have yet another argument to show reason against regarding the cavities of the paruterine organs in which the embryos are finally lodged as detached fragments of the pre-existing uterus; or, at any rate, to show that they cannot always be so regarded. In text-fig. 77 B and text-fig. 76 is represented an ovum lodged in one of the meshes of the parenchymatous network of the medullary region without any special relation to the larger egg-containing cavities which have been looked upon as detached fragments of a uterus. There are plenty of such examples to be seen in sections of this age, and it is plain to me that eggs are constantly lodged singly in the parenchymal network. I argue this from the fact that in these cases the cavities lodging the eggs are in every way indistinguishable in size and appearance from the cavities of the parenchyma in which an egg is not lodged. It may be, of course, that these are eggs which got extruded from a uterine cavity and forced into the surrounding parenchymatous network. But it is equally reasonable

to assume that they have got directly to their situation from the ovary (see text-fig. 76). The lax parenchymal tissue, the mesh-work of which is filled with a substance plainly visible as granular matter after staining with Ehrlich's hæmatoxylin, but not to be seen after staining with borax carmine, can offer little obstacle to the immigration of eggs; so that in any case some of the paruterine organs are without vestiges of an uterine cavity. I believe, as a matter of fact, that all are so, and that there is no persistent uterus in this worm.

The *paruterine organs* of this species resemble those of the species which I described as *Thysanotenia* \*. At the time when that description was written, I believe that Janicki's careful account of the genus *Inermicapsifer* with similar egg-capsules had not actually appeared. I had not realised from the descriptions of *Zschokkeella* that the organs containing the ripe eggs were doubtless of the same structure. I had considered that those organs probably resembled the figure given by Ransom †, not entirely grasping the fact that that figure was intended rather as a diagram to distinguish between those species of *Davainea* which had several eggs enclosed in one capsule and those species in which each capsule had within it but one egg. I was thus misled, though not through Mr. Ransom's fault. There was, of course, no other genus with which I could directly compare *Thysanotenia gambiana*.

In defining the genus *Zschokkeella*, Ransom speaks of the fate of the uterus in the following words:—"Uterus early breaks down into egg-capsules." Earlier in his résumé, Ransom defines the subfamily Linstowinæ in the same way; he remarks that the "uterus breaks down into egg-capsules." As the subfamily Thysanosominæ is defined by the presence (*inter alia*) of numerous paruterine organs, I thought myself justified in placing my genus, as I regarded it, in the latter subfamily and marked its affinities by the use of the generic name *Thysanotenia*. I was indeed of opinion that the uterus in *Zschokkeella* really persisted in separate pieces, each containing so many eggs. It appeared to me, in fact, after studying a tapeworm which I have lately described in the 'Proceedings' of this Society as *Otiditenia* ‡, that the fate of the uterus in *Zschokkeella* might be like that of *Otiditenia*. No figures are given by Fuhrmann in his account of *Zschokkeella linstowi* § which illustrate this particular point, and the only reference to the matter is the assertion that the eggs are surrounded by a "Parenchymhülle."

Janicki ||, however, is apparently of my earlier opinion; for, in distinguishing between the genus *Zschokkeella* (written, as originally—*Zschokkea*) of Fuhrmann and his own genus

\* P. Z. S. 1911, p. 1001.

† Bull. U.S. Nat. Mus. No. 69, 1909, p. 17, fig. 8.

‡ P. Z. S. 1912, p. 194.

§ Centralbl. f. Bakt. u. Paras. Bd. xxxii. (1902).

|| Loc. cit. p. 393.

*Inermicapsifer*, he uses the differences between the egg-capsules in the two genera. He considers that in *Zschokkeella* the eggs lie "einzeln in einfache Bindegewebskapseln," a difference which also appeared to me to hold good. I do not, however, feel confident about this point, and in view of other points of likeness between the genera am disposed to compare more nearly the paruterine organs in the two. In my paper upon *Otiditania* just referred to I have dealt to some extent with the "egg-capsules" of *Davainea*, of which the various figures published are not quite in unison. I find a justification for this in the paruterine organs of *Inermicapsifer capensis*, where the appearances vary slightly among examples which I cannot refer to different species.

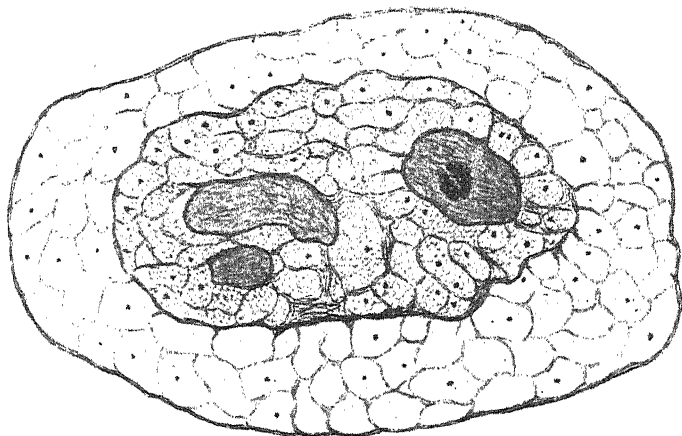
To begin with, I prefer the name of paruterine organs for the structures in question, because they seem to me to be exactly comparable to structures so named in other tapeworms. They are, in fact, sacs formed out of the parenchymal tissue, whether they have or have not ultimately a connection with the uterus. I should prefer to term the egg-containing spaces in *Otiditania* "egg-sacs" which are formed in a different way, *i.e.* by a breaking up of the uterus. When specimens of this *Inermicapsifer* were examined alive in salt-solution, the individual paruterine organs could easily be squeezed out of the body by crushing it. They were then spherical or egg-shaped and appeared to be surrounded by a thick, colourless, and almost structureless membrane. This membrane exhibited only faint striæ in a longitudinal direction, being thus concentric in reference to the whole body. The interior was filled with quite transparent spherical embryos, between which were abundant cells with granular contents.

In stained preparations (text-fig. 78) the outer layer was also perfectly distinguishable. It was stained more lightly than the inner by carmine and more deeply by logwood. A figure of the mature organ in *Inermicapsifer hyracis* is given by Janicki\*, with which may be compared my own figure of the same organ in the species described here. The appearances shown by the organ in the living condition are not borne out by preserved and stained material. The outer layer is not fibrous but cellular, as shown by Janicki and others. This layer is, however, as a rule, quite distinct from the inner mass of cells immediately surrounding the embryos. The distinction between the two partly depends, as already mentioned, upon stains, and is not always obvious. I do not see in my specimens of *Inermicapsifer capensis* so great a distinction between the outer and inner cells in point of size and shape as does Dr. Janicki, which is perhaps rather remarkable in consideration of the very different appearances they present when living. The cells of both layers are, in fact, rounded and nucleated, and not greatly different in size and shape. Those of the inner layer are filled with larger spherules. They are

\* *Loc. cit.* pl. xiv. fig. 28.

separated by a more deeply staining reticulum, which appears to be similar to that of the general parenchyma. This forms a somewhat thicker layer enclosing the whole organ. The reticulum of the inner mass of cells is thicker than that of the outer layer, and the nuclei lying at intervals along its strands are very obvious. The reticulum also forms a distinct layer separating the outer from the inner mass of cells. In fact, the whole organ is of an appearance more like that represented by Fuhrmann\* for *Davainea* than that by Janicki. This is so, at any rate, as regards the outer layer. The interstitial substance of the inner mass of cells forming the reticulum is represented by Janicki, but as of much greater relative extent than I have found it.

Text-fig. 78.



Paruterine organ of *Inermicapsifer capensis*, showing differentiation between outer and inner coat.

The species that has just been described cannot, as I think, be referred to any of those enumerated by Janicki. It differs from *I. hyracis* in the form of the scolex, in the fact that the testes are arranged in two separate masses in each proglottid instead of forming a continuous row. From *I. interpositus* my species differs also in the arrangement of the testes, and in the fact that the genital pores of *I. interpositus* are anterior in position and open into a well-marked cloaca, and also in the fact that the sexual products are ripe earlier in the body in *I. interpositus*.

Nor can *I. settii* be confused with my species. For in the former the body is very short and consists of not more than 70 proglottids. Moreover, the excretory vessels do not approach

\* Rev. Zool. Suisse, iv. (1896).

so nearly to the apex of the scolex; nor are they so coiled in that region as in my species. On the other hand, the two species agree in the posterior position of the genital pores and the separation of the testes into two masses. There may be a difference also in the lack of an excretory network in *I. settii*, of the existence of which Janicki is not certain.

There remain certain less-known species referred by Janicki to the genus *Inermicapsifer* with more or less certainty and of whose characters he gives some account. Of these, "*Tenia paronai*" cannot be identical with my species, since it possesses hooks; "*Tenia spatula*" of von Linstow is too imperfectly described to admit of its definite inclusion in the genus *Inermicapsifer*. It cannot, however, be identical with my species, since the cirrus sac is apparently much larger ("Der Cirrusbeutel nimmt 1/7 des Querdurchmessers ein") and the testes are scattered through the greater part of the segment. *Tenia ghondhorensis* of Klapotcz is very imperfectly known, but a pit upon the scolex shows that it is not identical with my species.

From *I. criticus* of Pagenstecher (which is perhaps identical with another species described below), the present species can be distinguished by the grouping of the testes into two masses.

*I. pagenstecheri* of Setti differs from my species by its few proglottids (not more than 80); otherwise it seems to present more resemblances to my species than any other form except *I. settii* by virtue of the posterior position of the genital pores.

To a species termed by Nasonov *Anoplocephala hyracis* Rud. var. *hepatica*, and by Janicki "*Inermicapsifer* spec.?" I shall recur in considering some worms from the gall-bladder of *Procavia capensis*. In the meantime my own species may be thus defined and named:—

### ***Inermicapsifer capensis*, sp. n.**

*Length about 95 mm., breadth 2 mm.; number of proglottids 200. Scolex wider than the neck. Proglottids at end of body nearly as long as wide. Genital pores unilateral near to posterior end of proglottids, not borne upon a conspicuous projection. Testes in two separate groups, one on pore side and one on opposite side of proglottid. Vas deferens forms a network; a large vesicula seminalis present; cirrus sac small, filled with slightly coiled and dilated sperm-duct. Uterus short and not persistent. Many paruterine organs, each containing several embryos.*

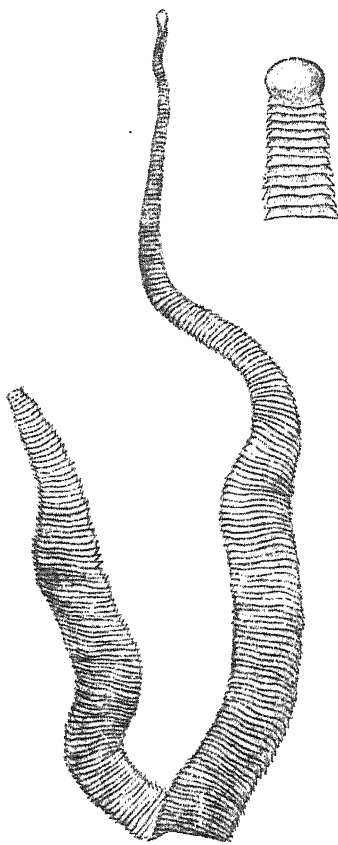
*Hab. Procavia capensis.*

### *On Species of the Genus Hyracotænia, gen. nov.*

Along with the numerous examples of the tapeworm which I have described here as *Inermicapsifer capensis*, I found in the gut of the Hyrax two complete or nearly complete examples of a tapeworm which has quite a different external appearance, and whose

internal structure is different from that of the former species. Before examining it anatomically it was, of course, impossible to say whether or no these worms belonged to the genus referred to, and even now it is possible that they may be of the same species as one or more of those which Janicki has—provisionally, at any rate,—assigned to the genus *Inermicapsifer*. They are, however,

Text-fig. 79.

*Hydracotania hyracis.*  $\times 2$ .

clearly not members of that genus, as the following account of their structure will prove. Nor can I, with any confidence, refer them to any other known genus. Hence I propose the above name, which is indicative of their habitat. I shall enquire later as to

the possibility of their identity with any other species known from the Hyrax. The two worms belong, as I think, to two different species, but are referable to the same genus without any doubt. I shall consider the anatomy of both of them together.

The larger specimen (text-fig. 79) measured about 90 mm. in length by a greatest diameter of 5-6 mm. The proglottids are very short in an antero-posterior direction, but, at any rate some way back in the body, rather thick. If there is a neck present at all it is very short. The scolex is unarmed and distinctly marked off from the strobila, but not much wider than the ensuing body. The latter increases gradually in width up to the widest point, and towards the end of the body again decreases. Of the smaller specimen I cannot give such precise details, since, believing at first that both specimens were of the same species, I investigated this individual anatomically without making full notes on its external characters. It was, however, rather shorter and of less breadth, while the anterior narrower region of the body widened out to the full dimensions rather sooner than in the larger specimen.

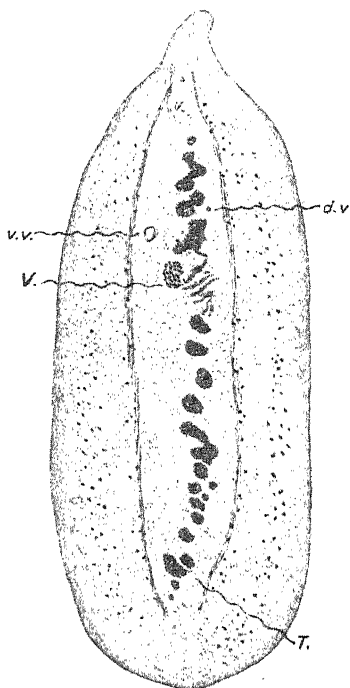
I have investigated the scolex by means of longitudinal sections only in the smaller specimen last referred to. The four suckers look directly upwards, their orifice being terminal in such sections. There is nothing remarkable that I could detect about their structure. They do not bulge to any extent from the sides of the scolex, and these sections show that the scolex is hardly, if indeed at all, wider than the immediately following strobila. The rudimentary rostellum is merely a hemispherical elevation lying between the suckers. There is no terminal pit of any kind and no hooks discoverable. The water vascular tubes extend into the rostellum. Of the larger specimen I only examined the scolex without destroying it. It is clear that the structure is the same in all the points mentioned above, but I am not able to report upon the water vascular tubes in this region.

The structure of the body-wall (text-fig. 80) also differentiates these two species from the *Inermicapsifer* whose anatomy has been described above. The principal difference lies in the much more marked layer of transversely running fibres which bound the cortical layer internally and the medullary parenchyma externally. This layer is very much the same—I think exactly the same—in both of the two individuals of this genus which I refer later to different species. It is composed of very delicate fibres; but the layer, as a whole, is rendered more conspicuous by the fact that large fibres belonging to the longitudinal layer occur between the transversely running fibres. The cortical parenchyma is nearly as thick as the medullary. The stout longitudinal fibres which run in the former are to be found in the greatest numbers at about the middle of the cortical layer, but they occur elsewhere. They are not massed into large bundles, but two or three are here and there closely associated. This massing of the longitudinal fibres is not obvious in the larger specimen.



The *excretory vessels* consist of the usual dorsal and ventral tubes running continuously through the strobila. Anteriorly there is less difference in the calibre of these tubes than posteriorly. The position in relation to each other also becomes altered. In immature segments (where I have studied the excretory tubes) the rather smaller dorsal vessel lies obliquely above the ventral vessel to the

Text-fig. 80.

*Hyracotenia hyracis.*

Transverse section through a proglottid.

*d.v.* Dorsal excretory tube. *T.* Row of testes. *V.* Vitelline gland.  
*v.v.* Ventral excretory tube.

pore side of the same. In maturer proglottids the two vessels are practically superposed, and the dorsal vessel is at times so minute as to escape observation. Both of these vessels are connected with a network of larger and smaller water vascular capillaries which traverse the medullary region of the body. I have seen branches of these ending in a testis, and it becomes a matter of

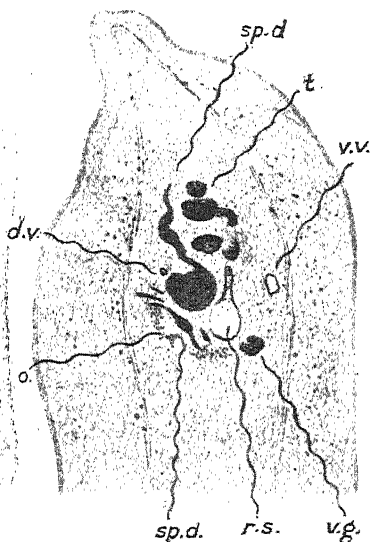
great interest to enquire if this network is directly connected with the network of vasa efferentia. But I have at present no further facts to offer.

The *ovary* of this tapeworm is unquestionably single. It lies on the pore side of each proglottid in the neighbourhood of the two longitudinal water vessels of that side. The ovary is apparently sometimes quite anterior to the testes, and sometimes is surrounded laterally by them. The vitelline gland is posterior to the ovary, which is thus the most anterior of the generative organs.

Text-fig. 81.



Text-fig. 82.



Text-fig. 81.—Part of a transverse section through a proglottid of *Hyracotænia hyracis*, to illustrate the immature ovary.

*d.v.* Dorsal excretory tube. *o.* Ovary. *v.v.* Ventral excretory tube.

Text-fig. 82.—Transverse section of one-half of a proglottid of the same species.

*d.v.* Dorsal excretory tube. *o.* Part of ovary. *r.s.* Receptaculum seminis.  
*sp.d.* Sperm-duct. *t.* Testes. *v.g.* Vitelline gland. *v.v.* Ventral excretory tube.

Its exact position with reference to the two water vascular vessels is not always identical. It is more dorsal or more ventral, as the case may be, and is sometimes entirely to the pore side of the ventral tube of the excretory system, and sometimes entirely to the median side of that tube; sometimes it extends to both sides. In any case it lies more or less between the dorsal and ventral excretory tubes. The ovary is not solid and compact, but arranged in a series of finger-like outgrowths radiating outwards and

dorsally. In young ovaries, such as the one figured in text-fig. 81, the riper eggs lie in straight lines connected by delicate threads with the central mass, and suggestive almost of the pseudopodia of a Rhizopod with the eggs carried along them. This radiating appearance of the ovary is retained until the organ is quite mature, when it consists of a group of sacs with, for the most part, definite walls, enclosed in which lie the ripe ova. I refer to this appearance of the ovary in considering the uterus on a later page. It seems possible that this condition of the ovary is to be compared to the testes, and that there are really several separate ovaries, which, however, are more closely adpressed than are the testes. In any case we have instances, like *Stilesia*, where the single ovary consists simply of a single mass of egg-cells, a condition which is to be compared with one of the subdivisions of the ovary in the present species.

The *vitelline gland* in the immature segments lies exactly opposite to the ovary, the vagina dividing, as described later, into two ducts, which end respectively in the ovary and vitelline gland. It is large and conspicuous in the mature proglottid. The *shell-gland* is also quite conspicuous in this tapeworm.

The *vagina* is wider and with thicker walls for a short space after its orifice on to the exterior. It then narrows and runs a very straight course towards the interior of the proglottid. It then becomes again wider, and opens gradually or abruptly into a dilated receptaculum seminis, which lies beside the vesicula seminalis. This region of the female duct is thin-walled. It is on a level with the ventral water-vessel. From the median end of the swollen receptaculum arise two tubes, one of them being the vitelline duct and the other the duct leading to the shell-gland and to the ovary. These two ducts are very much narrower than the receptaculum, into which they suddenly open. In immature proglottids the receptaculum is rather wider than the vagina, and gradually widens towards the internally situated end, there diverging into two horns which are respectively the vitelline duct and the ovarian duct. These ducts are in these immature segments of hardly less calibre than the end of the receptaculum into which they open. These and the sperm-duct pass towards the exterior between the dorsal and ventral water vascular tubes.

The terminal region of the vagina, *i. e.* that part nearest to the external orifice of the tube, has a lining which is very deeply stained by logwood, and so has the narrow region which immediately ensues; the rest of the vagina is not deeply stained in this way. I noticed in the larger of the two specimens which I report upon in the present communication that the narrow region of the vagina lying between the terminal part and the portion which may be termed receptaculum was much shorter than in the other example. I am not certain, however, whether there may not be some variation in this matter from segment to segment, an expansion of the lumen accounting for the different appearance. It

is certain, moreover, that the wide internal region of the vagina, before it divides into vitelline duct and ovarian duct, is susceptible to variation; for in some cases it was an abruptly formed spherical sac, at other times merely a wider tube than the immediately preceding region of the vagina. I mention later that the end of the receptaculum contains ripe ova in the mature proglottids. I have never seen spermatozoa therein.

*Uterus.*—In both of the two examples of this species the last few segments became somewhat shorter from side to side than those in front, and were also longer in the antero-posterior direction. One would naturally associate these changes in the facies of the proglottids with complete maturity and the existence in those segments of embryos. As I find in these segments completely ripe eggs quite detached from the ovary and associated together in small masses, I shall assume that the anatomical structure of these proglottids is that of complete maturity. In this case the present species differs from those which we have been considering by the entire absence of numerous paruterine organs like those of *Inermicapsifer*, etc. Even were these terminal segments not so fully mature as I presume them to be, there would be, I should imagine, at least some preparation for the formation of the paruterine organs. But there is none.

The ripe eggs were massed into more or less spherical groups surrounded by a membrane. These were not to be distinguished from the lobes of the ripe ovary, and I imagine that they were merely the persistent ovary. In addition to these masses of eggs, the end of the vagina, *i. e.* the dilated portion which I have termed receptaculum seminis, was found in many cases to be full or nearly full of ripe eggs unaccompanied by any interstitial cells. This was not only the case with a receptaculum which was swollen into a spherical contour at its base, but also in cases where the receptaculum ended merely as a slightly wider tubular sac. I have no reason whatever to doubt these facts, as the receptaculum is quite easy of identification. I am therefore disposed to think that there is no uterus as a distinct and separate structure, but that the eggs are partly voided into the receptaculum and partly remain *in situ* awaiting the loosening and perhaps disintegration of the proglottids. It may be that one of the rounded sacs which I regard as an ovary is really a uterus. Of this I cannot be positive, especially in view of the very few completely mature proglottids in both specimens. That both specimens were identical looks as if the conditions above described are to be regarded as normal.

The *testes* extend through a good part of each proglottid, and, as seen in sagittal sections, there are five or six rows of them laterally, though not so many in the median region. In transverse sections they are seen to extend from edge to edge of each segment, being nowhere interrupted save where they meet with the female reproductive organ. This row is mostly one deep, but in places two or even three deep. I counted from 40 to 50 or so of separate testes

in a single complete transverse series. There are thus altogether two or three hundred of these gonads to each mature proglottid. In more immature segments the testes did not appear to extend to the pore side of the longitudinal water-vessels but to stop short before quite reaching the median side of those vessels. In a mature segment I found that 44 out of the 50 sections which displayed it in its entirety were occupied by the testes, which thus fill up most of the segment, though the proportions were not always exactly as stated in the above instance. In proglottids from the other example of this species 3 sections without testes were followed by 15 sections showing testes, and these again by 5 without testes, and thereafter 14 with testes. It is therefore obviously the case that the testes occupy a great deal of the segments.

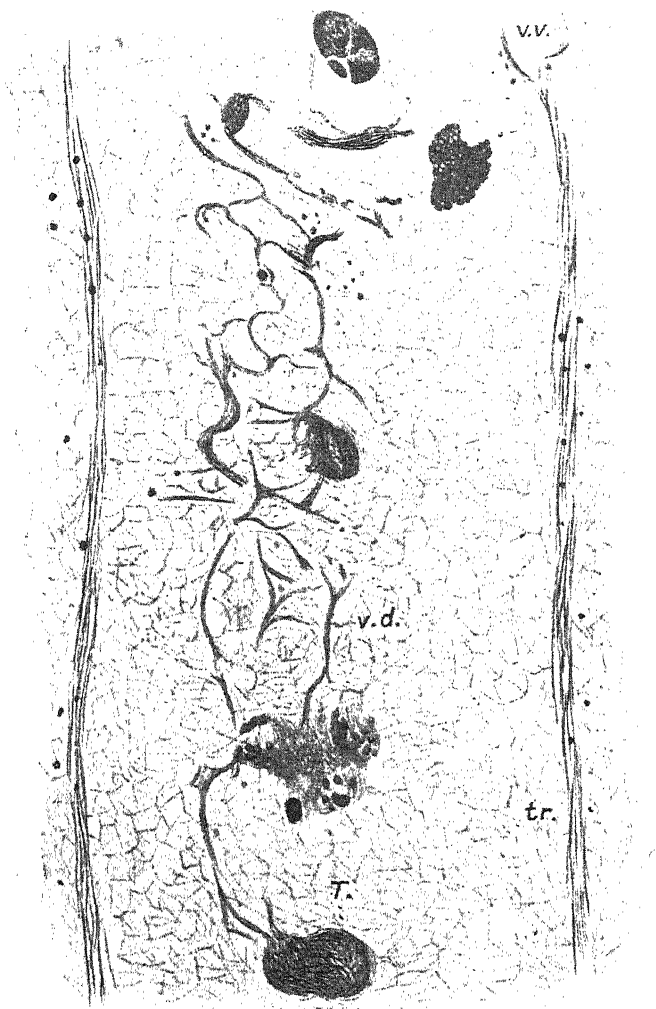
It will be observed that there is no grouping of the testes into two masses such as I have described in *Inermicapsifer capensis*. They lie mainly behind the ovary and vitelline gland, and in some proglottids the ovary lay rather more distinctly in front of the male gonads. The testes are more or less spherical or egg-shaped, and when ripe are seen to be surrounded by a layer of spermatozoa, which lie therefore, as I take it, in a cavity surrounding the testis, a coelomic cavity. I never found the testes of this tapeworm to be pear-shaped, like those of *Inermicapsifer*. Furthermore, the testes, all of them, lie dispersed in quite unaltered parenchyma. As is very generally the case among the members of this group, the testes were mature much more anteriorly in the body to the ovary. It is, indeed, a striking feature of the present species, and one in which it contrasts, for example, with the species of *Inermicapsifer* that has just been described, that the mature testes occupy so many segments of the body, while the mature ovaries are so exceedingly limited in the number of segments in which they are found. The efferent tubules which collect the sperm form a very definite network (see text-fig. 83), which is copious and formed often of unequally sized vessels. A similar network has been described in other tapeworms, for example in *Chapmannia* \*.

The *vas deferens* of this species (text-fig. 82, p. 597) is quite different from that of the species which we have already considered. The reticulate efferent ducts finally find their way into a large sac, which in the mature segments is stuffed with sperm, and which lies in the female generative mass alongside of the receptaculum ovarum. This large vesicula seminalis is flask-shaped, and therefore gradually narrows and emerges from the female generative mass as it passes towards the genital orifice. It is impossible to draw a hard-and-fast line between the vesicula seminalis and the sperm-duct proper with which it is continuous, for the gradual diminution in calibre of the entire tube forbids such a delimitation. The tube pursues a winding course, narrowing gradually and but slightly; it never forms an actual coil like the sperm-duct of so

\* See Fuhrmann, Swedish Zool. Exped. Egypt, 1909, pt. iii.

many other—indeed the majority of —*Tetracotylea*, but is at most once or twice bent upon itself. It becomes very narrow for a

Text-fig. 83.



Portion of medullary region of a proglottid of *Hyracotenia hyracis*, to illustrate network formed by vasa efferentia (*v.d.*).

*T.* Testis. *tr.* Transverse muscular layer. *v.v.* Ventral excretory tube.

short distance in front of its opening into the cirrus sac. The course of the sperm-duct is roughly parallel to that of the vagina, with which it might be sometimes confused in those cases where the vagina has not so abrupt a transition into the receptaculum.

Along the course of the sperm-duct, which in ripe segments is gorged with sperm almost throughout, there lie masses of what appear to be prostatic cells, similar in the fact of their existence to those of *Inermicapsifer*, but different in appearance. In the present species these cells are of a clear, almost hyaline, appearance, which is possibly due to the state of their activity at the time when the worm was killed. In *Inermicapsifer capensis* and in the species which I originally named *Thysanotenia gambiana*, the prostatic cells were darkly staining and granular. Nevertheless, they appear to be equivalent structures in the two tapeworms. In sections where the sperm-duct appears in transverse section, these cells present the appearance of a winding duct cut transversely. This appearance is due to the clear cells clustered round the actual sperm-duct, which, as already said, is narrow of calibre close to where it opens into the cirrus sac, and thus not obvious in such sections. There can be no mistake, however, in transverse sections of proglottids, where the course of the sperm-duct is easily to be followed owing to its being filled with sperm.

In the second and larger individual there are certain definite differences in the form of the sperm-duct. The tube has no such great dilatation into a vesicula seminalis, and it is very much more coiled as it approaches the cirrus sac. It has, in fact, the large and close coil which is so typical of tapeworms. There is certainly nothing of the kind in the other individual. The clear cells already spoken of form a complete layer one cell thick round the mass of sperm in the sperm-duct, and are therefore, I take it, simply the epithelial wall of the sperm-duct. As the sperm-duct was in parts full of sperm, this difference cannot be owing, I believe, to the different stages of the maturity of the proglottids in this tapeworm as compared with those already described. It must, I think, be a specific difference, with which also, it will be observed, go differences in the position of the ovary and vitelline gland.

The *cirrus sac* of this worm is not at all large as in the allied forms comprised in the genera *Inermicapsifer* and *Zschokkeella*. It can be seen in sagittal sections to lie straight in front of the vagina close to the external aperture, and I have not noticed any genital cloaca. There is certainly nothing of any size, and in one section the penis was seen to protrude on to the exterior directly from the cirrus sac without any intermediate and common chamber. The cirrus sac is oval in form and surrounded, as is usual, by a strong layer of muscles. I could not see any indications of a flask shape such as is so common in tapeworms. In the interior of the sac are the usual nuclei belonging, it is to be presumed,

to delicate muscles which retract the cirrus. The latter was relatively wide and short and the sperm-duct within the cirrus sac not coiled. The protruded male copulatory organ reminded one rather of the penis of *Anoplotenia*\* than of a cirrus, for it was wider at the free end than just within the cirrus sac.

It is evident that this genus presents many resemblances to the genera *Zschokkeella* and *Inermicapsifer*†. It agrees with those genera in the following assemblage of characters:—The head is unarmed and the excretory tubules form a plexus, or at least a coil, at the very extremity of the rostellum, as in the species which has just been described; the segments are narrow and the genital pores are unilateral. The excretory tubules furthermore form a plexus within the medullary parenchyma throughout the body. The ovary lies to the pore side of the segments and is distinctly not a double organ; the vagina dilates into a wide receptaculum seminis. The cirrus sac, moreover, is small as contrasted with that of many other tapeworms. On the other hand, there are certain characters which argue against this placing of the worm whose anatomy has just been described. These are as follows:—The sperm-duct in our species is short and almost immediately dilates into a large and long seminal vesicle, a state of affairs which is not met with in the species of *Inermicapsifer* known at present. Finally, the network formed by the vasa efferentia is a feature hitherto unknown in the genus *Zschokkeella*, though it occurs in *Inermicapsifer*. Inasmuch as a reticular disposition of the vasa efferentia is not necessarily diagnostic of a given genus as far as we know, for it occurs in *Chapmannia lapica* and *Hymenolepis reticulata* and not in other (at any rate in some other) species of that genus, this fact alone would not perhaps necessitate the removal of the present species from the genus *Zschokkeella* to which other important characters would appear to assign it. But there is a negative character which may be of very great importance. In neither of the two individuals which I have studied was there the least trace of the formation of the characteristic "egg-capsules," which I prefer for reasons already given to call paruterine organs.

In all the species of *Zschokkeella* and *Inermicapsifer* examined from this point of view, the formation of these capsules began perhaps rather far back in the body, but still a long way before the actual termination. Now both examples of the present genus in my possession ended posteriorly in a few segments which were rather longer than those preceding them and at the same time rather narrower, suggesting, in fact, the end of the body. They were, moreover, thicker than unripe segments. If this be not the completely mature end of the body, the worm would be very exceptional in the deferring of the egg-reservoirs to a point so very far behind the scolex. Besides, two specimens selected at

\* See Beddard, P. Z. S. 1911, p. 1015, text-fig. 215.

† For the generic distinctions see below, p. 607.



random from the same host would hardly be likely to prove both abnormal in any way. Finally, we have in these segments rounded sacs with ripe eggs, though it must be admitted that these were eggs and not embryos. Some riper proglottids may, however, be missing; but even then the commencement of the paruterine organs would surely be visible.

It is therefore, as I think, impossible to include these worms in either of the genera with which I have just compared them. Of the remaining Anoplocephalidæ (to which family I think that these worms must be referred) there are only the genera belonging to the subfamily *Anoplocephalinae*. Of these *Cittotania* and *Moniezia* need not be considered, since their generative apparatus is double in each segment. Of the remaining genera none agree with the two worms under consideration in all of the following points, viz., uterus at most inconspicuous, cirrus sac small, genital pores unilateral, ovary to pore side of proglottids, genital ducts pass between excretory vessels, testes posterior. I believe, therefore, that they must be referred to a new genus.

This new genus may be thus defined:—

### **Hyracotænia.**

*Scolex unarmed, with four unarmed suckers. Proglottids wide and very short, a little longer at extreme end of body, but always much wider than long. Genital pores unilateral, not borne upon papillæ. Cortical parenchyma thick, separated from medullary by a thin layer of circular fibres. Water vascular tubes four, dorsal and ventral, the latter larger, connected by a network of capillaries. Testes numerous, dorsal in position, lying behind and to sides of ovary; vasa efferentia forming a network; sperm-duct wide and sinuous or coiled; cirrus sac small; a short blunt wide penis protrusible. Ovary near water-tubes of pore side, single, in front of vitelline gland; dilated receptaculum seminis and very narrow vagina. Uterus small and sac-like; paruterine organs absent.*

*Hab. Procaria capensis.*

It is not possible for me to distinguish definitely at present between generic and specific characters. The above embody characters usually considered in generic definitions. The two species may be, for the present at least, defined as follows:—

#### **(1) *Hyracotænia procavia*, sp. n.**

*Length about 90 mm.; greatest diameter 5–6 mm. Body attains its greatest width about 25 mm. from anterior end. Testes very numerous. Sperm-duct rather dilated posteriorly, much coiled anteriorly. Ovary ventral, on outer side only or both sides of ventral vessel; vitelline glands dorsal. Vagina not greatly dilated posteriorly.*

(2) *Hyracotænia hyracis*, sp. n.

Length about 70 mm.; greatest diameter 4·5 mm. Body attains its greatest width about 6 mm. from anterior end. Testes less numerous. Sperm-duct much dilated posteriorly, sinuous but not coiled anteriorly. Ovary more dorsal, to median side of water-vessels; vitelline glands ventral. Vagina usually much dilated posteriorly.

We now come to the consideration of the question of the possible identity of either or both of the above species with any of those enumerated from the Hyrax by Janicki. The only species of that series that can be considered (if, that is to say, there are really no paruterine organs in the forms described by myself) are *Tenia* (*Anoplocephala*?) *gondokorensis* of Klaptocz\*, *Tenia* (*Anoplocephala*) *spatula* of v. Linstow†, and *Anoplocephala hyracis*, var. *hepatica* of Nassonow‡, termed *Inermicapsifer* spec.? by Janicki. Of these Klaptocz's species has a small scolex like the species described by me, but also an apical depression (? a rudimentary rostellum) which my species have not. Furthermore, the proglottids appear to be much smaller. In the species of v. Linstow we find too great a breadth, and the cirrus sac is too large for comparison with my species. The shape and proportions of Nassonow's species are like mine, but the scolex has a conical process. In all these species the details are insufficient.

There are thus in African animals—chiefly in Mammals (mostly in the Hyrax (*Procavia*), but also in Rodents and Lemmings), but extending to Birds (*Numida ptilorhyncha*)—a group of worms which show at least specific differences, but all of which have the following characters in common, viz., head unarmed and no neck, proglottids wider than long and as a rule very much so, genital pores unilateral, cirrus sac not very large, testes numerous, ovary not double. To these characters may possibly be added, if we exclude the species described above as *Hyracotænia* spp., or are led by further material to interpret their anatomy differently, the formation of numerous paruterine organs—or egg-capsules as they have been termed by others.

These characters (excluding the fate of the uterus) seem to me to necessitate the inclusion of this group of worms in the family Anoplocephalidæ.

The various species which agree in the foregoing characters cannot, however, on these alone be massed into one and the same genus without further consideration. If we subtract from the assemblage the species which I have described as *Hyracotænia procavia*, and which, as I think, must in any case be withdrawn from the group, the reasons for uniting the rest under a single generic name become more striking. For in this case all of the species possess paruterine organs of the same kind, unless, indeed,

\* S.B. Wien. Ak. 1906.

† Jen. Zeitschr. Naturw. xxxv. 1901.

‡ Arb. Zool. Lab. Univ. Warschau, 1897.

Janicki be right in inferring that *Zschokkeella* really differs, a point which I have already gone into above (see p. 590). The description of a second species of *Zschokkeella*\* from a *Cercopithecus* does not throw any further light upon this particular matter. If it were not for the fact that *Davainea* seems in some of its species to possess paruterine organs of the same type, the African worms referred to might well be regarded as all congeneric, in which case, of course, *Zschokkeella* would have to be the name.

Janicki appears to me to be rather hard put to it to separate his *Inermicapsifer* from *Zschokkeella*. The differences are certainly small. As already stated, he relies upon supposed differences in the paruterine organs of which I am disposed to doubt the existence. He also mentions the thickness of the muscular walls in *Zschokkeella* as compared with *Inermicapsifer*, and a few other points which seem to me to be of minor importance and not even collectively as of generic rank. Janicki's comparisons are based chiefly upon his own account of *Inermicapsifer hyracis*, which was the only species investigated by him in a detailed fashion. I do not think that a further examination of other species referred to by Janicki will necessarily prove the identity of *Inermicapsifer* and *Zschokkeella* throughout. I would point out that my own account in the present paper of *I. capensis* shows some differences between that species and *I. hyracis*. These differences are mainly the posterior position of the genital pore, the existence of a vesicula seminalis, the complete separation of two groups of testes, and the presence of a rete mirabile along the course of the sperm-duct. Finally, the uterus is much more rudimentary in *I. capensis* than in *I. hyracis*. In some of these characters it would appear that *I. settii* agrees with my species and differs from *I. hyracis*. A further examination of these species may show that they agree in other characters not referred to by Janicki in his résumé of these forms.

I would reserve the generic name *Inermicapsifer* for these forms and refer "*Inermicapsifer*" *hyracis* to *Zschokkeella*. There now remains my genus *Thysanotenia*. Of that genus I have described two species which show many differences of structure. *Thysanotenia gambiana* is, as I now think, undoubtedly to be referred to *Zschokkeella*, with which it agrees in all points, if we may assume that the paruterine bodies are identical in the two. On the other hand, it will be, as I think, advisable to retain the name *Thysanotenia* for the second species of the genus (*T. lemuris*), which differs mainly in the following points:—There is no plexus of excretory tubes and the ventral vessel is very large, the dorsal being apparently absent in mature segments; the ventral vessels are connected in each segment by the usual transverse trunks; the receptaculum seminis is quite different from that of the other forms; the uterus

\* *Z. remota*, see v. Linstow, Zeitschr. wiss. Zool. lxxxii. 1905.

is more rudimentary than in *Zschokkeella*. I should distinguish the various genera thus:—

- I. Excretory system forms a network in each segment. Receptaculum seminis long and forming end of vagina. Cirrus sac small.
  - A. Genital pores median on edge of segment. Testes forming a continuous row. No vesicula seminalis. Uterus well developed at first . . . . . *Zschokkeella*.
  - B. Genital pores posterior on edge of segment. Testes in two groups. Large vesicula seminalis present. Seminal ducts form a network. Uterus never well developed.  
*Inermicapsifer*.
- II. No excretory network. Receptaculum short and globular along the course of vagina. Cirrus sac rather large.
  - A. Genital pores on conspicuous papilla. Testes forming continuous row. Uterus never well developed.  
*Thysanotania*.

This arrangement is naturally only tentative, since we are at present in need of more information concerning the majority of the species already known from the Hyrax and enumerated by Janicki in the paper which has been so often referred to. There are also points in the structure of the species referred to the genus *Zschokkeella* which demand further investigation.

### 32. Additional Notes on the Living Specimens of the Australian Lung-fish (*Ceratodus forsteri*) in the Collection of the Zoological Society of London. By BASHFORD DEAN.\*

[Received February 9, 1912: Read April 2, 1912.]

(Text-figures 84 & 85.)

#### INDEX.

	Page
Development and Coloration .....	608
Regeneration of injured portion .....	611

The two specimens of the Australian Lung-fish in the Zoological Society's collection have been living under unchanged conditions since 1898, *i. e.* about fourteen years. In this time they have been observed repeatedly by zoologists, whose interest in these important and rare batrachian-like fishes has led them, in several instances, to publish their notes in detail. There is still, however, much to learn about the habits of these fishes, and it is to be hoped that the opportunity will be seized generally to observe the present specimens, especially

\* Communicated by the SECRETARY.

since it is fair to assume that they are living under fairly normal conditions. In this connection it may be mentioned that the fishes have been subjected to no changes in their aquarial habitat; indeed, they have remained practically undisturbed for over a decade.

Among the notes dealing with these specimens are those of the present writer, published six years ago in the 'Proceedings' of the Zoological Society of London (1906, vol. i. pp. 168-178), a contribution which gave also data about *Ceratodus* summarized from earlier literature. In this paper details were recorded regarding the movements of the fishes, their mode of breathing, both with gills and lungs, their manner of feeding, their nocturnal activity, and in general their salamander-like habits.

The writer had again the opportunity of observing these specimens during June 1911; his supplemental notes are as follows:—

*Colour*.—One of the fishes, the larger one, remains notably darker than the other. This distinction in colour, therefore, is neither abnormal nor seasonal. Nor can there be vast adaptive colour changes in *Ceratodus*, for the reaction to similar surroundings would then be the same in the two fishes. Is the darker specimen a male?

So far as could be learned, the fishes have shown no evidence of sexual activity. The colours have remained constant, and there have been no signs of the brilliant tones noted by Schmeltz (1876, J. Mus. Godeffr., vol. viii. p. 138). According to his account, the ventral side of *Ceratodus* is of a deep orange-red, and several scales on the sides are margined with red; nothing is said, however, of the relation of these colours to the season. From the characters of the present specimens, and by analogy with *Amia*, we can safely conclude that the tones of orange and red appear only at the time of spawning. In *Amia*, aquarium-kept fishes show no bright colours, but under native conditions the male fish develops wonderful brilliancy; the spot at the base of the tail is conspicuous, red scale-margins appear, and the hinder abdomen glows with tones of orange.

It was noted (1911) that the paired fins were margined with a narrow white band. Could this have been an indication of a breeding colour? No coloration of this kind was seen on the edges of the unpaired fins.

*Size*.—At present the darker specimen measures  $33\frac{1}{2}$  inches, the lighter  $29\frac{1}{2}$  inches, having grown but a very few inches during the past seven years. They have reached, accordingly, nearly their greatest length, Macleay leading us to infer that 3 feet is about their maximum (Cat. Austr. Fishes, p. 284). Exceptionally, however, a specimen may measure 45 inches, such a case having been cited by O'Connor (1897).

*Age*.—The present specimens give us an idea of the age to which *Ceratodus* may attain. We have in the first place data that they have grown, broadly speaking, at the rate of three quarters of an

inch annually for the last thirteen years. At this rate the present fishes are over forty years old, and a fish of the record size (45 inches) would be over sixty. But this assumes that the rate of growth in length is approximately uniform in fishes of different ages. In point of fact it is known that fishes in all groups grow quickly when young, and slowly, if at all, when old: it is also known that under favourable conditions a fish may grow with far greater rapidity. In the case of *Ceratodus* the rate of growth of the young is as follows:—

Length of specimen. inches	Age.	
$\frac{8}{16}$ .....	At hatching.	} Notes from stages reared in balanced aquaria in Gayndah, Queensland, by Mr. Thomas Illidge.)
$\frac{12}{16}$ .....	$\frac{1}{4}$ month.	
$\frac{9}{16}$ .....	$1\frac{3}{4}$ month.	
$\frac{11}{16}$ .....	2 months.	
1 .....	$2\frac{1}{2}$ months.	
$1\frac{1}{8}$ .....	6 months.	
$1\frac{1}{2}$ .....	7 months.	
$2\frac{3}{16}$ .....	$7\frac{1}{2}$ months.	
$2\frac{5}{8}$ .....	8 months.	

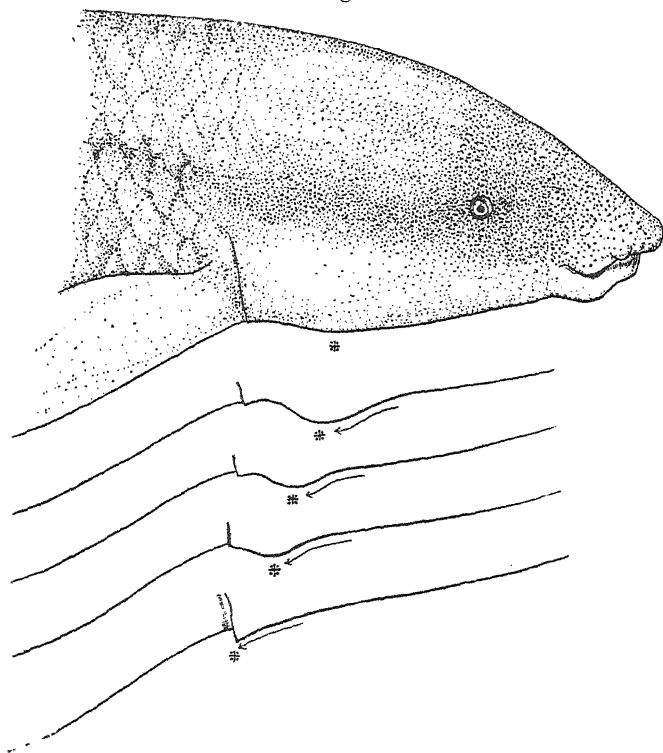
In stages lately hatched the growth is seen to be rapid, its rate suggesting that a specimen 12 inches in length might be not older than a year. The rate, however, changes notably when the young fish no longer subsists on its yolk. In fact, for a period of about two months it actually decreases in size, a state of affairs, however, probably abnormal and due to the lack of proper food in the aquarium. Young an inch long are nine weeks old; young two inches long are over seven months old. At the end of the first year the young *Ceratodus* measures, we infer, about five inches, a rate of growth which would be not unlike that in young *Amia*, gar-pikes, or in a number of teleostean fishes. If the analogy with known ganoids continues, a two-years' *Ceratodus* would measure 8-9 inches; and a specimen 25 inches in length, approximately the size of one of the present fishes when it appeared in London, is estimated to be from eight to ten years old; this added to the thirteen years of their living in the Society's aquarium, makes the total age of the present specimens between, roundly, twenty and twenty-five years. Older and larger specimens it is fair to credit with great age, probably fifty years.

*Breathing.*—The aquatic respiration of *Ceratodus* varies considerably according to the temperature of the water, but its range has not been observed. In September (1904), on a cool day, with water temperature not far from 65° Fahrenheit, the respiratory movements were "slow and regular; the opercular cavity filled and emptied about twelve times a minute." In late June, when the water temperature was nearly 75°, the successive

movements of the gills varied from twenty-two to thirty-one a minute. Both fish had long been quiet; if their movements had been active there is no doubt that this rate would have been notably exceeded.

Rhythmic movements in breathing are well shown in the opercular membrane. In the early stage of breathing the cheek in the subopercular region is seen to dilate slowly and strongly; this dilated region is then passed (rather slowly) backward, and

Text-fig. 84.



Opercular movement in breathing of *Ceratodus forsteri*.

The crest of the undulatory wave is indicated by the asterisk.

its enclosed water is discharged (text-fig. 84). During this process the dilated part becomes more and more conspicuous until the final discharge, and at that moment the free rim of the gill-opening is thrown outward and drawn forward, exposing the lighter coloured hinder border of the gill-slit. The free border up to that time has been closely apposed to the head.

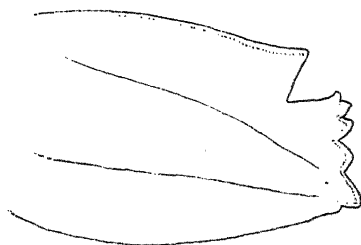
It was earlier noted that *Ceratodus* is a "nostril breather."

The mouth itself showed no noticeable movement of opening or closing; it was indeed hardly open, the gape scarcely more than  $\frac{1}{8}$  inch. During the later observations, the mouth was seen slightly to open and close; its maximum gape noted (measured close to the glass) was  $\frac{1}{4}$  inch, its minimum  $\frac{1}{8}$  inch. The opening of the mouth was here doubtless correlated with the higher temperature of the water and the more rapid respiratory movements. In general, however, the mouth margin was almost motionless, the fish breathing through the nostrils.

In the matter of breathing air at the surface, *Ceratodus* shows greater variability than earlier noted. On one occasion over seventy minutes elapsed without either fish coming to the surface.

*Feeding.*—Little was added to the former notes. The only detail suggests that minute food, in the form of algae together with vegetable debris, forms a part of the normal diet. It was observed that the fishes would "nose" about in corners and suck in this finer material. In the process little pebbles would sometimes be taken in and retained for a few moments, then rejected—the process several times repeated, in a fashion which suggested that the stones thus mouthed yielded food sought for by the fish. It was noted in this connection that the stones in the aquarium were in many cases well coloured with algae.

Text-fig. 85.



Pectoral fin of *Ceratodus forsteri*, showing regenerating margin.

*Movements.*—The writer's preceding paper gave a number of figures showing characteristic movements of *Ceratodus*. The only addition to this series would be a variant of the fig. 11 there given; the right hand pectoral remained in its resting position (as in fig. 14); the left, however, was suddenly twitched up over the back several times (as in fig. 11), but in this case brushed close to the body, giving the observer the amusing impression that the fish was thoughtfully rubbing its head. The habit was curiously unlike that of a fish; it suggested rather the movement of a tetrapod; and a very similar movement is known in urodeles.

*Regeneration.*—The larger (dark coloured) specimen had suffered an injury to the left ventral fin; a portion of it near the tip



had been lost and the margin was regenerating. Text-fig. 85 illustrates how far this process had extended. It will be seen that the restitutive proliferations were most active along the free distal margin of the fin. Here several (four) eminences were present, each suggesting the pointed tip of the fin; there can, however, be no doubt as to which of these is the terminal one, since the skeleton of the fin can be followed into the lowest of these lappets. The case is evidently akin to one known to teratologists, for when certain areas in injured limbs of batrachians are stimulated, there appears polydactyly or polypody. It may therefore be worthy of record that a similar condition occurs in the lung-fish *Ceratodus*.

33. The Circulatory System of the Common Grass-Snake (*Tropidonotus natrix*). By CHAS. H. O'DONOGHUE, B.Sc., F.Z.S., Assistant to the Jodrell Professor of Zoology, University College, London.

[Received April 1, 1912 : Read April 23, 1912.]

(Plates LXX.-LXXII. and Text-figures 86-91.)

INDEX.

	Page
I. Introduction .....	612
II. The Heart.	
A. Development .....	614
B. Adult Form .....	617
III. The Arterial System.	
A. Development .....	619
B. Adult Form .....	621
(a) Anterior Vessels .....	621
(b) Posterior Vessels .....	623
IV. The Venous System.	
A. Development .....	626
B. Adult Form .....	630
(a) Anterior Vessels .....	630
(b) Posterior Vessels .....	631
V. The Vessels of the Head.	
A. Arteries .....	635
B. Veins .....	640
VI. List of References .....	643
VII. Explanation of Plates .....	645

I. INTRODUCTION.

Our knowledge of the circulatory system in snakes is far from exhaustive; indeed, we have only a complete account of the vessels in the Python by Hopkinson and Pancoat (25), and a later and a more full one by Jaquart (26), and in *Pelophilus madagascariensis* by Gadow\*. Although *Tropidonotus natrix* is

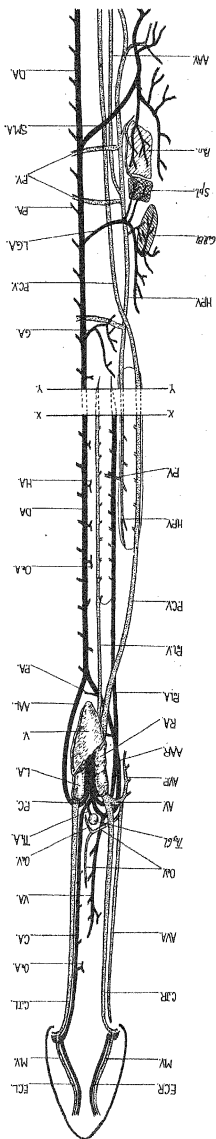
\* This is incorporated in the account given by Hoffmann (23).



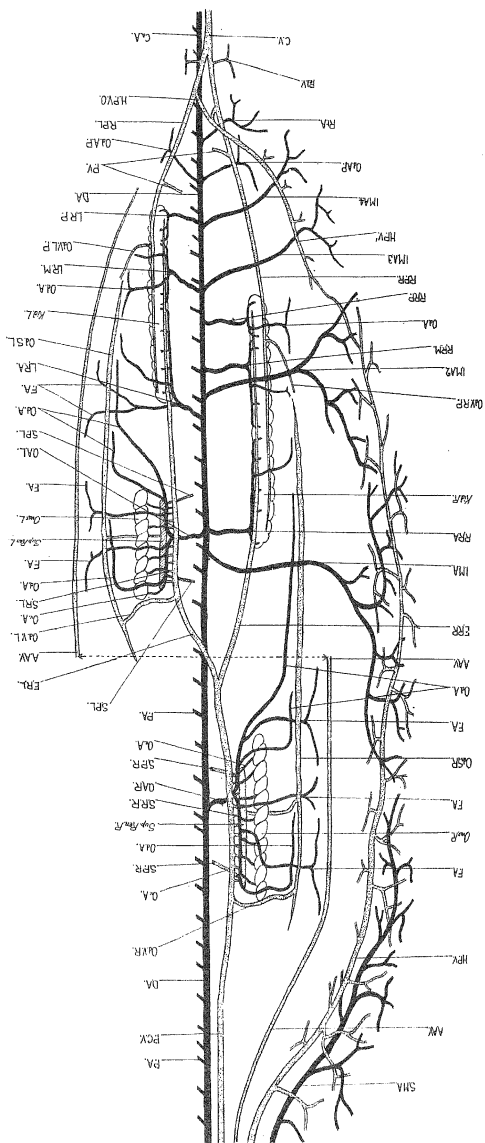
# CIRCULATORY SYSTEM OF THE GRASS SNAKE.

Cham H. O'Donoghue, del.

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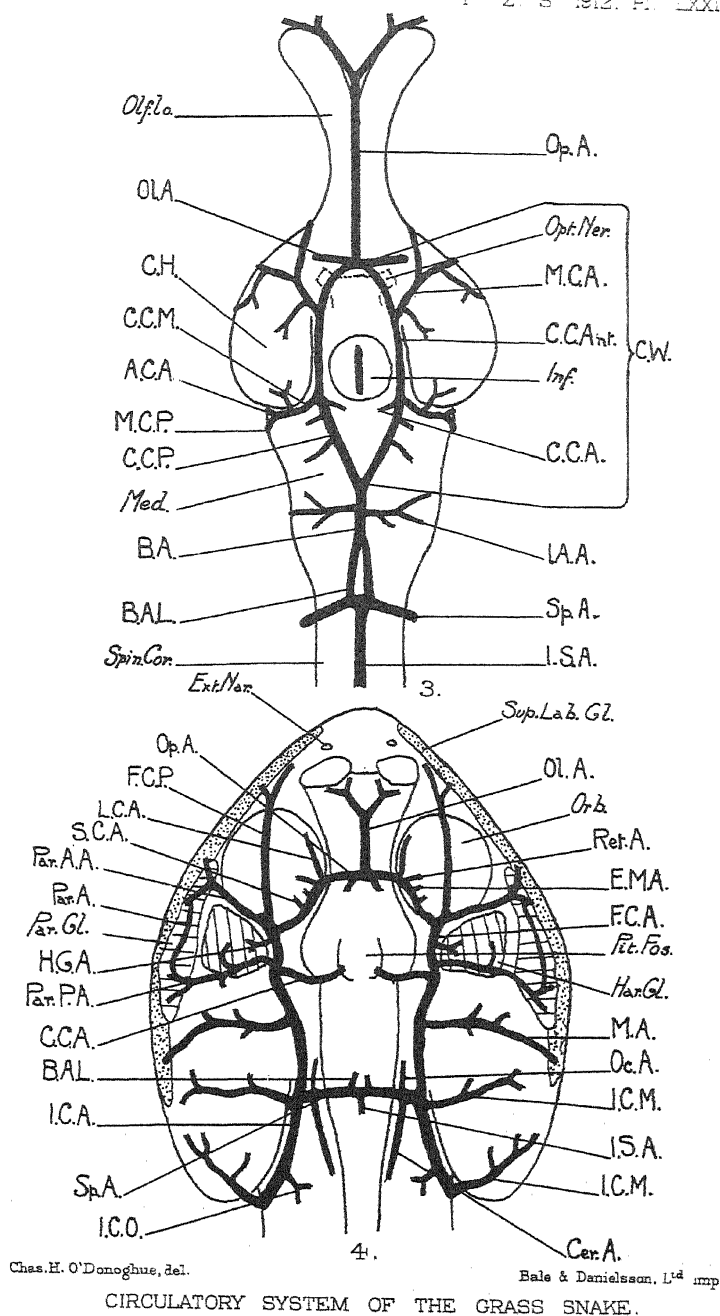


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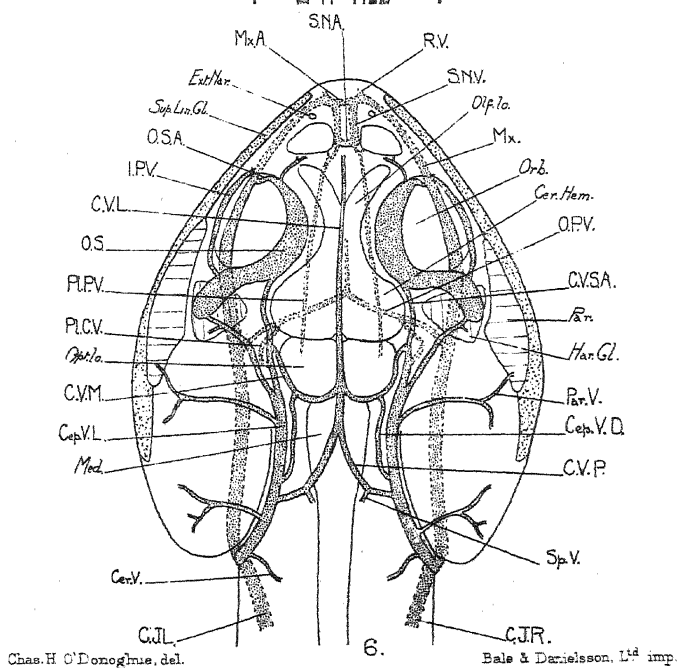
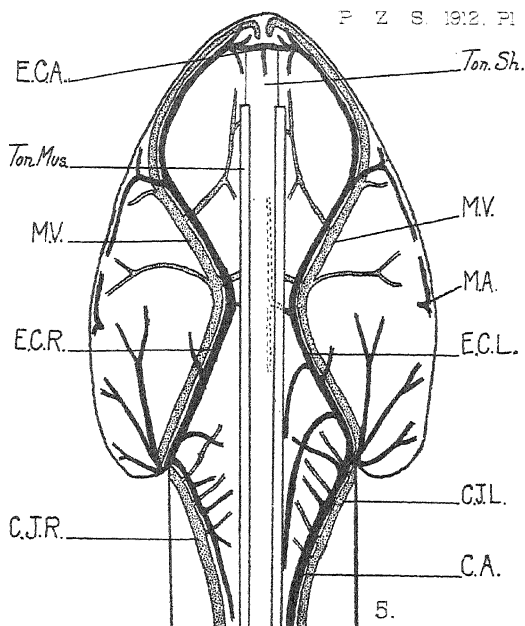


Chas. H. O'Donoghue, del.

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CIRCULATORY SYSTEM OF THE GRASS SNAKE.









the snake most commonly dissected in the laboratories of this country, no description of its vascular system has appeared since the anatomical account of the blood-vessels in snakes written by Schlemm (35) in 1827, which was based largely on *Coluber* (i. e. *Tropidonotus*) *natrix* and *Trigonocephalus mutus*. This account by Schlemm, although excellent in many respects, is by no means complete, and, owing to the overlooking of the cerebral carotid artery, the remaining arteries of the head are misinterpreted. A great deal of work has been done, however, on different parts of the circulatory system of this animal by various authors. We are indebted to Rathke for a valuable account of its development (30) and also of the arteries of the head and neck (31); the last is the best general account of these vessels in snakes that has been written as yet. Hochstetter has dealt with the development of the posterior veins (20) and of the blood-vessels in general (22), Grosser and Brezina (19) with the development of the veins in the head and neck, and Bruner (12) with the veins and sinuses in the head of the adult.

In addition to these works bearing directly on *T. natrix*, Beddard (1-6) has added considerably to our knowledge of the blood-vessels of other snakes, and the intracranial circulation has been dealt with in the vertebrate series in general by De Vriese (14) and Hofmann (24) and in reptiles by Dendy (13).

The blood-vessels of the Grass-Snake were investigated by means of the dissection of a number of injected specimens. The injection fluid used for the main vessels was that recommended by Kingsley (28), i. e.,

Corn starch and 2 per cent. chloral hydrate (each) 400 vols.  
95 per cent. alcohol 100 vols. and Colour and glycerine (equal parts) 100 vols.

For the finer vessels a gelatine mixture advised by Tandler (36) was used, i. e.,

5 gms. of gelatine in 100 c.c. of distilled water coloured with Berlin blue or carmine.

5-6 gms. of potassium iodide added slowly while warming gently.

These are two very good mixtures, as the first will keep almost indefinitely, and the second, with the addition of a few crystals of thymol, will keep in a stoppered bottle for months, and, in addition to being useable when almost cold, will withstand acids. By mixing a quantity of the gelatine mass with about one-third or less of its volume of the solid residue that settles to the bottom of the starch mixture, an extremely useful general injection mass is obtained. The latter mass, which flows very readily if only slightly warmed, and sets firmly and fairly quickly in 70 per cent. alcohol or in 4-5 per cent. formalin, was the one most frequently employed in making the preparations for this investigation.

For the sake of clearness in description, the account of the blood-vessels of the head is not included in the general description of the vascular system of the whole animal, but is dealt with separately later. A brief account of the development of the heart and of the arterial and venous systems has been introduced in order to throw some light on the condition that obtains in the adult.

Two or three features of general interest in connection with the elongation of the body and the loss of limbs in the Ophidia are clearly brought out in dealing with the vascular system of the Grass-Snake. The first is the marked asymmetry of the viscera and their blood-supply; not only are the organs of the right side anterior to those of the left, but they are also considerably larger. Thus the right ovary, supra-renal body, and the kidney are in front of and larger than the corresponding organs on the left, and, as is well known, in the case of the lungs the left one is entirely suppressed.

Secondly, the tendency to form longitudinal systems of vessels, common to all Ophidia, as Beddard (1) pointed out, is well marked. The various arteries supplying the intestine and the fat-bodies are in each instance indirectly connected into one long system. The ovarian artery forms a longitudinal trunk along the corresponding supra-renal body. Among the veins also we find that the hepatic portal vein runs from one end of the intestine to the other, and that each oviduct possesses a sinus running beside it for the greater part of its length. This oviducal sinus is very conspicuous in *T. natrix*, although it does not appear to have been described previously in other snakes. The liver, too, is greatly elongated, and the post-caval vein and the hepatic portal vein pass along its opposite faces from one end to the other.

Lastly, the blood-vessels of the adult, with the exception of a small pair of veins in the cloacal region, which may represent the pelvic veins of Lacertilia, give no indication of their derivation from those of a limb-bearing ancestor.

In conclusion I should like to express my sincere thanks to Professor J. P. Hill of this College for the kindly assistance and advice he has given me throughout the work.

## II. THE HEART. (Pl. LXX.)

### (A) *Development.*

The development of the heart has been very fully dealt with by Rathke (30), and as this account differs but slightly from that of *Lacerta* given by Greil (18) and Hochstetter (20), it does not appear necessary to give more than a brief outline here.

The primitive heart is in the form of a simple tube stretching in an antero-posterior direction in the region of the gill-slits. Its posterior end is formed by the union of the two omphalo-

mesenteric veins, and the anterior is continued as the short common stem (*truncus arteriosus*) of the first pair of branchial arches. It soon bends towards the right, and as the two ends remain in approximately the same position, while the tube itself grows longer, it is forced to take on a curved form. In this twisted condition three portions can be distinguished: first, a posterior part running from the union of the omphalo-mesenteric veins, close to which now open the paired *ductus cuvieri*, ventrally and towards the left; secondly, a median part situated ventrally and running obliquely from left to right; and thirdly, an anterior part running from the right to the median line, where it bends sharply dorsally before passing over into the *truncus arteriosus*, from which, by this time, two pairs of branchial arches are given off.

Grooves appear on the posterior part of the tube which indicate the divisions between *sinus venosus* and atrium and between atrium and ventricle. Into the *sinus venosus* now open the paired umbilical veins. The middle part, afterwards to become the ventricle, becomes dilated ventrally, and as the anterior part also dilates, the two parts are separated by a deep furrow. According to Hochstetter (20) and Langer (29) this anterior part is homologous with the *bulbus cordis* of the *Batrachia*.

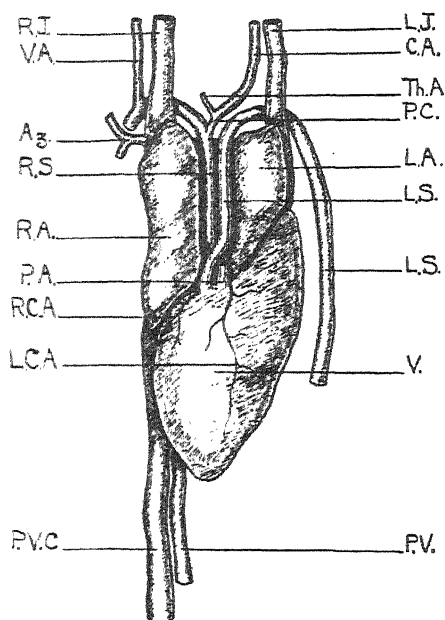
The ventricle expands still further and moves caudally, so that the atrium, which has also become dilated, comes to lie close to the *bulbus cordis*. The further dilatation of the atrium takes place cranially and towards the left, causing it to take up a position on the left side of the *bulbus*. The constriction between the atrium and ventricle, corresponding to the auricular canal, becomes more marked as these two structures swell out. At this stage, too, the *sinus venosus* is sharply constricted off from the atrium and the *truncus arteriosus* gives off the six pairs of branchial arches. Rathke erroneously described only five branchial arches, but this will be referred to again later.

After this the ventricle gradually assumes its adult shape. The base of the *bulbus cordis*, originally joining the ventricle on the left, moves into an almost mid-ventral position. Spirally twisted grooves appear between the branchial arches, now reduced to three in number, and extend downwards over the *bulbus*. The atrium now gives off another dilatation, but this time to the right, and consequently the *truncus arteriosus* and *bulbus cordis* lie in a deep groove between the outgrowths of the atrium. These two dilatations are the definitive auricles, and already the *sinus venosus*, which lies in the atrio-ventricular sulcus on the dorsal side of the heart, opens into the one on the right.

The groove between the *bulbus* and the ventricle gradually disappears, and ultimately the proximal part of the *bulbus* becomes incorporated with the latter, while its distal portion becomes assimilated to the *truncus arteriosus*. The spiral grooves finally extend over the whole of the so-formed *truncus*, and they indicate its internal division into three parts by the

backward growth of two septa. One, the septum aortico-pulmonale, arises from the edge of the pulmonary artery, and as it grows it divides the truncus cavity into two tubes, an aortic and a pulmonary. The other, the septum aorticum, arises between the two aortic arches, and so subdivides the aortic cavity of the truncus into two, a right and a left. Of the three tubes formed in this way, one lies to the left, ventrally, and leads to the pulmonary arch; another lies to the right, ventrally, and leads to the left aortic arch; and the third lies dorsally and leads to the right aortic arch.

Text-fig. 86.



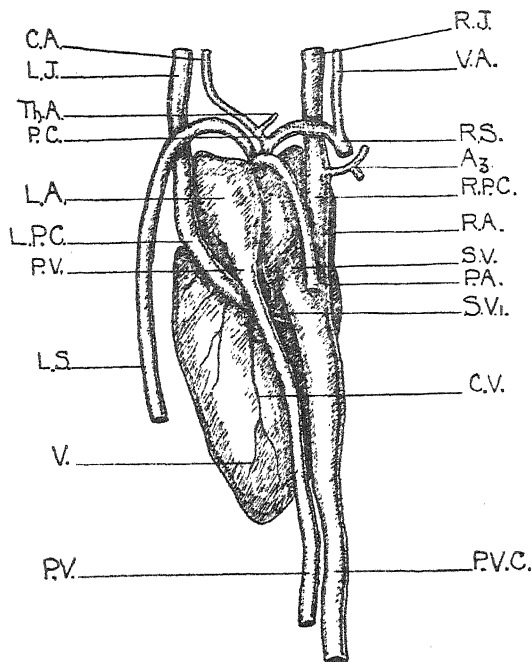
Ventral view of the heart and adjoining vessels.

Az. Azygos vein. CA. Left common carotid artery. LA. Left auricle. L.C.A. Left coronary artery. L.J. Left common jugular vein. L.S. Left systemic arch. PA. Pulmonary artery. P.C. Primary carotid. P.V. Pulmonary vein. P.V.C. Post-caval vein. RA. Right auricle. R.C.A. Right coronary artery. R.J. Right common jugular vein. R.S. Right systemic arch. Th.A. Thyroid artery. V. Ventricle. V.A. Vertebral artery.

Lastly, the sinus venosus also assumes its definitive form. After the disappearance of the umbilical and omphalo-mesenteric veins, it has opening into it, on the right, the right ductus Cuvieri and the post-caval, while on the left it has the left ductus Cuvieri. Thus we have practically the adult condition of the

heart, which, however, in the course of the further development moves caudally, and ultimately comes to lie a long way from its primitive position.

Text-fig. 87.



Dorsal view of the heart and adjoining vessels.

C.V. Coronary vein. L.P.C. Left pre-caval vein (left common jugular). R.P.C. Right pre-caval vein (right common jugular). S.V. Major part of sinus venosus. S.V.I. Minor part of sinus venosus. Other letters as in text-fig. 86.

(B) *Adult Form.*

*Tropidonotus* in common with all the reptiles, except the Crocodilia, possesses a three-chambered heart. This is situated a considerable distance behind the head and slightly towards the right. It is enclosed in a pericardium in which it lies freely, not being attached to it by a gubernaculum cordis as is the case in the heart of the Lacertilia and Crocodilia. Beddard (2) has pointed out that although a gubernaculum cordis is generally absent in snakes, it is not completely so, as a homologous structure occurs in some species\*. The pericardium on the right side lies

\* E. g. *Coronella getula*, *Cœlopeltis monspessulana*, and *Ophiophagus bungarus*, Beddard (*loc. cit.*).

against the body-wall, while on the left side it is separated from it by the intervention of the oesophagus. In conjunction with the elongated form of the body, we find that the heart also is long and narrow.

The *Sinus Venosus* is situated on the dorsal surface of the heart, and appears as a saccular structure divided into two parts and formed by the swollen extremities of the common jugular veins and the post-caval veins (text-fig. 87). It is hardly distinguishable externally from the right auricle, although internally the two cavities are separated by the bicuspid sinu-auricular valve. The right common jugular vein from the anterior end of the body and the post-caval from the posterior end join together to form the major part of the sinus venosus, which lies on the right of the dorsal surface of the heart. The left common jugular vein runs down along the outer edge of the left auricle and then across in the groove between the left auricle and ventricle (text-fig. 87). Its mouth opens into the smaller part of the sinus venosus\*, which is partially separated from the major part by a valvular septum. The efficacy of this septum is seen when injecting, for while the right common jugular and post-caval veins may be easily injected from the major part of the sinus, it is almost impossible to inject the left common jugular from it.

The thin-walled *Auricles* (text-fig. 86) are unequal in size, the right, of an elongated oval form, being much larger than the left, which is shorter and more rectangular. Into the right auricle opens the sinus venosus and into the left the single pulmonary vein (text-fig. 87). The opening of the pulmonary vein is not guarded by a valve as Fritsch (16) pointed out, but it seems highly probable, as Sabatier (33) suggested, that during systole a fold of the auricle in this region functions as a valve and so prevents regurgitation. The auricles are completely separated by an imperforate inter-auricular septum which is continued caudally so as to divide the auriculo-ventricular aperture into two. The internal surfaces of the auricles possess a network of raised muscular ridges, the *musculi pectinati*.

The *Ventricle* is somewhat oval in shape, but very asymmetrical. The posterior end forms a bluntly conical apex, and the base, although more or less transverse on the right side, is produced anteriorly on the left side into a conical process, so that the left side of the ventricle is nearly as long again as the right. It is extremely thick-walled, and its cavity contains a large number of muscular trabeculae, some of which interlace in such a way as to form an oblique, incomplete ventricular septum. This partial septum keeps the aerated blood brought in by the left auricle more or less completely separated from the non-aerated blood from the right auricle. Two valves, a right and a left, similar in arrangement to those in *Lacertilia*, guard the auriculo-ventricular apertures.

\* They do not open separately into the auricle as stated in Rolleston (32).

The *Bulbus cordis*, as has been pointed out above, is not to be found as a separate structure in the adult, and so the three aortic arches arise directly from the ventricle. The base of each of these is guarded by two semilunar valves, which Langer (29) has shown to be homologous with the distal row of valves in the amphibian heart.

### III. THE ARTERIAL SYSTEM. (Pl. LXX.)

#### (A) *Development.*

The development of the aortic arches in *Tropidonotus* is very similar to that of other Reptilia\*. It was first described by Rathke (30), whose general account has been confirmed since by Van Bemmelen (7 & 8) except in one particular. Rathke

Text-fig. 88.

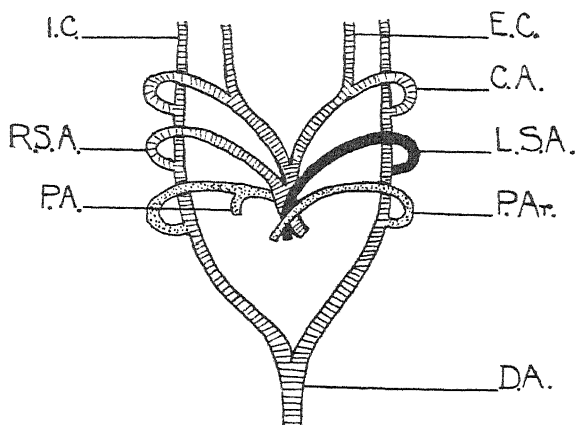


Diagram of embryonic arterial arches. It represents the condition after the disappearance of arches 1, 2, and 5, and shows also the division of the truncus arteriosus into three arterial roots.

C.A. Common carotid. D.A. Dorsal aorta. E.C. External carotid. I.C. Internal carotid. L.S.A. Left systemic arch. P.A. Pulmonary artery. P.Ar. Pulmonary arch. R.S.A. Right systemic arch.

Adapted from Hochstetter (22).

describes the development of only five visceral arches on each side, which he numbered from the anterior end 1-5. Van Bemmelen, however, showed that there was another arch, which has however, a somewhat transient existence, between arches 4 and 5 of Rathke, so that the latter's fifth arch is in reality the sixth of the series, and thus the snake is brought into line with other Amniota.

\* For a general account of this see Hochstetter (22).

These arches soon become reduced to three on each side, viz. 3, 4, and 6, by the disappearance of arches 1, 2, and 5. Of the remaining arches, 3 is the carotid, 4 the systemic, and 6 the pulmonary. By the separation of the truncus arteriosus into three tubes the two carotids and the right systemic have a common opening into the ventricle; the left systemic opens separately, and the two pulmonaries open by a common vessel (text-fig. 88). The most remarkable change in the development is the enormous lengthening of the carotids, brought about partly by the elongation of the neck but largely by the caudal shifting of the heart. Thus it happens that in the adult condition the 3rd arch is far removed from the 4th and 6th arches.

Text-fig. 89.

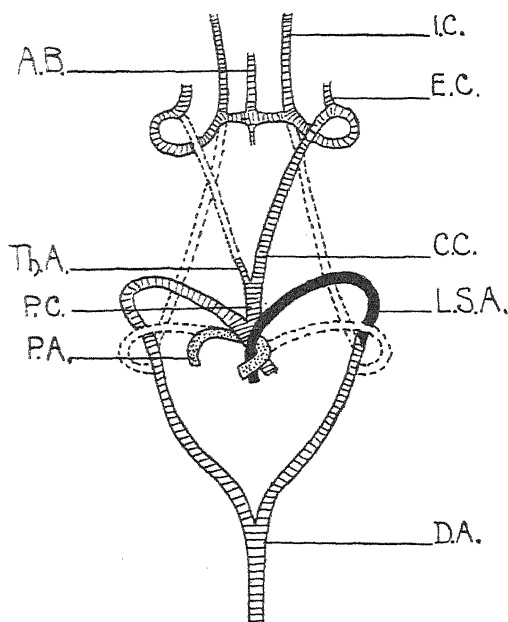


Diagram to show changes in embryonic arterial arches. It shows the change from the condition in text-fig. 88 to the definitive state. The filled-in portions represent the vessels left in the adult, and those indicated by dotted lines the vessels that disappear in the course of development.

A.B. Basilar artery. C.C. Left common carotid. P.C. Primary carotid. Th.A. Thyroid. Other letters as in text-fig. 88.

Adapted from Hochstetter (22).

The *Carotid Arch* goes through considerable changes in the course of its development. The two common carotids arise from the systemic by one root, the primary carotid (*carotis primaria*



of Rathke), which remains short as in most snakes\*. After the common carotids have split into internal and external carotids, each internal vessel gives off a branch which enters the neural canal with the first spinal nerve and joins the basilar artery on the ventral side of the nerve-cord. These branches quickly widen out and, forming as they do an anastomosis between the two internal carotids, make it possible for the right common carotid to degenerate. This it does completely† from the point where it divides into internal and external branches down to close to its union with the left common carotid, but the last part of it remains and is to be found in the adult as a small artery supplying the Thyroid gland (text-fig. 89).

The *Systemic Arch* undergoes very little change during development.

The *Pulmonary Arch* degenerates almost completely on the left side. In conjunction with the suppression of the left lung in *Tropidonotus*, we find that the pulmonary branch of the 6th arch is only developed on the right side. In the adult only one pulmonary artery is to be found.

#### (B) *Adult Form.*

##### (a) *Anterior Vessels.*

The *Left Aorta* bends dorsally around the œsophagus and trachea and then posteriorly to unite with the right aorta in the mid-dorsal line. During this course it gives off two very small branches to the œsophagus, but none whatever to the parietes.

The *Right Aorta* takes a corresponding course on the other side, during which it gives off the following branches:—

I. The *Left and Right Coronary Arteries* arise behind the two semi-lunar valves which guard the base of the aorta. The right coronary artery runs in the groove between the auricle and ventricle, and is the chief supply of the dorsal surface of the heart. The left passes around the base of the pulmonary artery and spreads out over the ventral side of the heart.

\* In some snakes it is absent altogether, so that the common carotids come off separately from the systemic arch, e. g. *Boa*.

† It is interesting to note, however, that in some variations of *T. natrix* this does not occur, and so the two common carotids persist in the adult. The first specimen of *T. natrix* that I examined was in this condition, although in all other respects it appeared a perfectly normal adult male. The two common carotids, left and right, sprang from a common stem, the primary carotid, and were about equal in calibre. On the left side the carotid pursued a normal course. The abnormal right carotid passed ventral to the œsophagus, just behind the thyroid gland, to which it sent a small branch, over to the right side of the neck. From here up to the posterior end of the skull it followed a similar course to its fellow on the left. Unfortunately the vessels of this specimen were not injected, so that the relation of the persistent right carotid to the basilar artery could not be ascertained. However, this apparent anomaly in the arterial system is quite readily understood in the light of the developmental history of these vessels. Only one other example of this peculiar abnormality seems to have been described before, and that by Van Bemmelen (9), but in this case the right carotid was only a fine tube.

II. The *Primary Carotid* (Carotis primaria, Rathke) is a short trunk which quickly divides into two unequal branches :—

- i. The *Thyroid Artery* is the smaller of the two, and, in addition to supplying the thyroid gland, it sends a twig to the right thymus glands. This is the sole remnant of the right common carotid.
- ii. The *Left Common Carotid* (Arteria carotis communis, Rathke, Arteria cephalica, Schlemm) runs along the left side of the œsophagus and trachea, to which it sends three or four slender branches, until it reaches the posterior region of the head. Here it divides into internal and external branches, and supplies the whole of both sides of the head. (The distribution of this vessel in the head will be dealt with later.)

III. The *Vertebral Artery* (Arteria vertebralis, Rathke, Arteria collaris, Schlemm) arises from the anterior dorsal part of the right carotid arch and runs forward, a little to the right of the vertebral column about half-way to the head. It gives from three to seven branches to the parietes and one or more to the œsophagus before disappearing into the vertebral musculature in the mid-dorsal line.

IV. Five *Parietal Arteries* are then given off. The first three are very slender and close together, while the remaining two are of the same size as the regular parietal arteries.

V. One or two small *Œsophageal Arteries* run to the œsophagus.

After this the two systemic arches unite to form a single vessel, the dorsal aorta.

The *Left Ductus Botalli* is not completely closed up in the course of development, and its proximal portion is to be found in the adult animal as a cul-de-sac running cranially from a point low down on the root of the right carotid arch\*. This remnant varies somewhat in size in different individuals, and although it is always more or less short, is of nearly the same calibre as the right carotid. It is completely hidden by the left auricle, but is readily seen if that body be carefully removed. From its somewhat bluntly conical end comes off a thin strand of tissue which runs forward into the left systemic arch at the point where it bends over to run backwards. This represents the closed part of the left pulmonary arch, and is therefore the left ligamentum Botalli, such as has been described by Brenner (11) and Hochstetter (21). I find myself in agreement with the former author also when he states that he was unable to find a right ligamentum Botalli in *Tropidonotus natrix*.

According to Brandt (10), quoted also by Hoffman (23), there

\* Such a saecular appendage appears to be present generally in those snakes with one lung suppressed, and has been recorded by Hochstetter (21) in *Tropidonotus natrix*, *T. tessellatus*, *Coluber æsculapii*, *Coronella lavis*, *Vipera berus*, and *Cerastes vipera*.

is present in the Grass-Snake a solid strand of tissue joining the primary carotid to the transverse part of the left aortic arch and called by him the *ligamentum caroticum*. This, he states, in exceptional cases may remain open and may then be described as a *ductus caroticum*, and is a vestigial structure somewhat similar to the *ductus Botalli*. In the hearts I have examined no trace of this vessel or cord could be found, and, indeed, no such connection exists in the course of embryonic development, as a glance at text-figs. 88 and 89 will show. A connection between the carotid and left aortic arches is present in the embryo, but in the adult it would run from the dorsal part of the left systemic arch along the whole length of the neck up to the point of origin of the internal carotid (text-fig. 89). This, however, does not fit in with Brandt's description of the *ligamentum caroticum*.

#### (b) Posterior Vessels.

The *Right Pulmonary Artery* (*Arteria pulmonalis*, Schlemm) arises separately from the ventricle and leaves the heart the most dorsal of the three arterial roots. It runs backwards alongside the œsophagus almost parallel with the right systemic over which, however, it passes ventrally, and then runs dorsal of the post-caval vein to the anterior end of the lung. As it passes along the right border of that organ it gradually gets smaller and smaller until it disappears as a distinct vessel at the level of the posterior end of the liver, although the lung is continued on for some distance.

In correlation with the suppression of the left lung no left pulmonary artery is found at any time.

The *Right and Left Aortic Arches* unite posterior to the heart to form the dorsal aorta.

The *Dorsal Aorta* runs in the body-cavity just ventral to the vertebral column, back to the level of the cloaca. Just posterior to this it leaves the body-cavity and enters the hæmal canal, and in this is continued along the tail as the *Caudal Artery*. During its course through the cœlum it gives off a number of branches.

The *Parietal Arteries* form a numerous and more or less regular series of branches going to the body-wall, of which there are about twelve up to the point of origin of the superior mesenteric artery. These arteries enter the body-wall in the mid-dorsal line, a characteristic of most colubrine snakes, and do not split into two before so doing, as in the pythonine snakes (*cf.* Beddard, 4 and 1).

The *Esophageal and Hepatic Arteries*.—In front of the liver the dorsal aorta gives off two or three slender branches to the œsophagus. After these come a series of common trunks, about fifteen in number, which divide into two branches, one going to the liver and one to the œsophagus or posteriorly to the stomach. The last of this series is considerably larger than the others and has more branches, some of which go to the anterior end of the stomach.

The following vessels then come off from the dorsal aorta in order:—

1. The *Lieno-gastric Artery* is the first of these. Its gastric branch is the main artery supplying the stomach, and it also sends a branch to the spleen, and yet a third, the cystic artery, to the gall-bladder. No branch of it goes to the pancreas, nor does the superior mesenteric artery send twigs to the spleen and gall-bladder as Beddard (1) has described in *Tropidonotus fasciatus*.

2. The *Superior Mesenteric Artery* is the largest vessel arising from the dorsal aorta. Soon after its origin at about the level of the pancreas it divides into two branches; a smaller one, the duodenal, running anteriorly supplies the part of the intestine immediately after the pylorus and also the pancreas; a much larger one running posteriorly supplies the many coils of the intestine as far back as the posterior end of the right ovary. Small branches from it also supply the anterior part of the fat-body. I have been unable to find any branch of this artery running to the right ovary such as Beddard (1) recorded in *Tropidonotus fasciatus*.

3. The *Right Ovarian Artery*, a moderate-sized vessel, runs to the right supra-renal body and, dividing into anterior and posterior branches, forms a longitudinal vessel along it. From this longitudinal trunk are given off:—

- (a) Six small ovarian arteries of equal size.
- (b) Three somewhat larger oviducal arteries. One of these arises from the anterior end of the longitudinal vessel and supplies the fimbriated opening of the oviduct, and the other two arise from the posterior end.
- (c) Three fat-body arteries—an anterior, a small median, and a posterior.
- (d) A number of fine twigs to the supra-renal body.

The posterior of the three fat-body arteries in some cases has an independent origin from the aorta.

4. The *First Inferior Mesenteric Artery* supplies the coils of the intestine just posterior to the right ovary. Its point of origin varies, however, in different individuals and in the two sexes, as will be pointed out below.

5. The *Anterior Right Renal Artery* conveys blood to the anterior half of the right kidney, and also gives off a branch to the right oviduct.

6. The *Left Ovarian Artery* is distributed in a very similar way to the right, and from the longitudinal trunk it forms along the supra-renal body come off:—

- (a) Five equisized ovarian arteries.
- (b) Three oviducal arteries. The anterior again supplies the oviducal funnel.
- (c) Two fat-body arteries.
- (d) A number of fine twigs to the supra-renal body.

As on the right side the posterior of the fat-body arteries may arise separately from the aorta.

7. The *Anterior Left Renal Artery* divides soon after its origin into two branches, one going to the fat-body and the other to the kidney. This latter branch supplies the anterior half of the kidney and sends a twig to the oviduct.

8. The *Second Inferior Mesenteric Artery* arises about the level of the anterior end of the left kidney, and supplies the intestine in the region of the median part of the right kidney.

9. The *Median Right Renal Artery*, in addition to taking blood to the posterior median part of the kidney, sends a branch to the right oviduct.

10. The *Posterior Right Renal Artery* feeds the posterior end of the kidney and gives off two branches to the oviduct.

11. The *Third Inferior Mesenteric Artery*, arising near the level of the posterior end of the right kidney, supplies the intestine in the region of the posterior part of the left kidney.

12. The *Median Left Renal Artery* is distributed very similarly to the corresponding vessel on the right.

13. The *Fourth Inferior Mesenteric Artery*, arising at the level of the posterior end of the left kidney, supplies the last part of the intestine.

14. The *Posterior Left Renal Artery* resembles its fellow on the right, save that it does not send a branch to the oviduct.

15. The *Posterior Oviducal Arteries* are a pair of arteries running to the posterior ends of the oviducts. In addition to this there may be one or two small twigs going to the rectum.

16. The *Rectal Artery* is a small vessel supplying the last part of the rectum.

An *Epigastric Artery* is present, and it appears to be similar to that described by Beddard (1) in *Ophiophagus bungaris*, that is, it runs along the body-wall in the mid-ventral line in close connection with the epigastric vein, and is fed by branches from the carotid anteriorly and the fat-body posteriorly. Its precise relations are somewhat difficult to make out, for it is a vessel too small for individual injection, and in order to get a satisfactory injection of the arterial system it is necessary to open the snake from end to end, dissect away the skin, and free the gut to some extent. This, however, necessitates cutting either the epigastric artery itself or some of its small tributaries.

The arrangement of the vessels in the male snake is very similar to that just described for the female. All the arteries anterior to and just posterior to the heart are precisely the same, and it is not until the region of the urino-genital organs is reached that we find any difference.

Each testis receives one spermatic artery as is general in snakes, which first runs to the supra-renal body, whence it sends branches to the testis and also to the vas deferens. These two spermatic arteries are each followed by another vessel that runs to the posterior part of the supra-renal body and also supplies the vas deferens for a considerable distance, that on the right side also sends a branch to the fat-body.

The kidneys each possess an anterior and a median renal artery as before, but instead of one posterior trunk there are at least two, but most often three\*. These vessels also send small twigs to their respective vasa deferentia, and the left anterior renal supplies the fat-body with a large artery.

The supply to the alimentary canal is also slightly different. The first of the inferior mesenteric arteries arises posterior to the anterior left renal artery, whereas in the female it is anterior to the anterior right renal†. This is followed by a series of about four smaller inferior mesenteric arteries. The various mesenteric arteries are connected by their small branches and so form more or less of a longitudinal system along the gut.

The origin of the arteries supplying the fat-bodies in both sexes is fairly similar and is somewhat interesting. The anterior part is supplied by branches from the superior mesenteric artery, the next portion by vessels from the right genital artery, and the posterior end is fed by branches from the left genital and left renal supply. In addition to which the posterior branch from the genital artery on each side may in some cases arise independently from the dorsal aorta. All these branches are joined one to the other by small twigs into a longitudinal system running the whole length of the fat-body, but there does not appear to be one unbroken artery, an arteria epiploica, traversing the whole length of the fat-body.

#### IV. THE VENOUS SYSTEM. (Pl. LXX.)

##### (A) *Development.*

The general course of the development of the venous system in *Tropidonotus* is similar to that of other reptiles (*vide* Hochstetter, 22), but it has some points peculiar to itself (*vide* Rathke, 30, and Hochstetter, 23).

The first veins to appear are the two omphalo-mesenterics, of which the right is somewhat stouter than the left (the reverse is the case in *Lucerta*), and they open into the sinus venosus. Soon after their appearance the anterior and posterior cardinal veins arise on each side, and their common stem unites with the umbilical vein on each side to form the ductus Cuvieri, which becomes associated with the omphalo-mesenteric veins at the

\* The number of renal arteries varies in different species, being only one in *Python spilotes* and eight in *Coronella catenifer*, Beddard (1).

† This differs from the account of *T. fasciatus* in Beddard (1), where "it springs from the aorta in both sexes close to the second (*i. e.* left) gonad artery, in front of it in the male, behind it in the female." Some variation is to be found, however, in the position of this artery in different individuals, for in the females of *T. natrix* that I have examined, although it has generally been in front of the right anterior renal and left ovarian arteries, it may be behind these vessels. In the male it is usually behind the left anterior renal artery, but it may be in front of it. It has not occurred anterior to the right anterior renal artery in any male snake that I have examined. Again, we find considerable variation in the number of these gut-arteries in various snakes. *Lachesis gramineus* has only one, while in the genus *Coluber* there may be ten or eleven (Beddard, *loc. cit.*).

point where they open into the sinus venosus. An anastomosis between the two omphalo-mesenteric veins forms on the dorsal side of the gut just posterior to the pancreas rudiment, and the portion of the left vein between this point and the sinus venosus disappears. A similar anastomosis between the two veins now forms on the ventral side of the gut, and thus a complete ring is formed. In a short time, however, the right half of this ring disappears, leaving a single vein which runs in a spiral manner round the gut. While these latter changes are taking place, the middle part of the right omphalo-mesenteric vein between the sinus venosus and the dorsal anastomosis spreads out and forms a venous network in the liver. The portion of the right omphalo-mesenteric vein in front of the hepatic network persists as the hepatic vein, and the part behind it always remains as the anterior end of the hepatic portal vein (text-fig. 90).

Text-fig. 90.

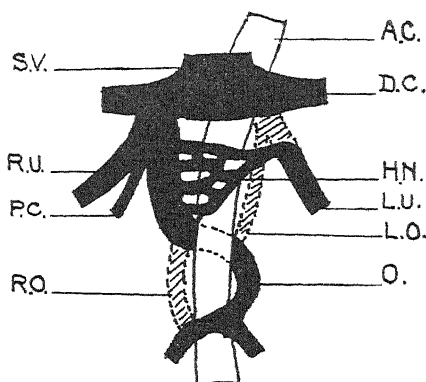


Diagram of posterior veins in the embryo. It shows the change from an early to a late embryonic condition. The shaded vessels being the first to disappear.

A.C. Alimentary canal. D.C. Ductus Cuvieri. H.N. Hepatic network. L.O. Left omphalo-mesenteric (soon disappears). L.U. Left umbilical. O. Omphalo-mesenteric. P.C. Post-caval. R.O. Right omphalo-mesenteric (disappears later than L.O.). R.U. Right umbilical. S.V. Sinus venosus.

Adapted from Hochstetter (20).

The posterior cardinal vein originates at the caudal end of the mesonephros, and runs forward along the dorso-lateral edge of that body. After leaving the kidney, however, it breaks into several branches, which soon reunite and then it runs into the ductus Cuvieri. When the caudal vein develops it divides into two branches at its anterior end, each of which runs to the extremity of the corresponding cardinal vein (not along the mesial wall of the kidney as in *Lacerta*). The post-caval vein springs from the union of the right umbilical and omphalo-mesenteric

veins and runs backwards in the mesentery to the kidneys. Between them it breaks up into two branches, which run posteriorly along their mesial borders. These branches meet the kidneys at a point some distance from their front end, and there each receives a branch from the anterior part of the kidneys. Subsequently the parts of the posterior cardinal veins in front of each mesonephros disappear, and so all the blood from the caudal veins has to pass through those organs.

Still later the adult kidney arises caudally to the mesonephros, and then the end part of each posterior cardinal vein comes to lie on its ventral and external border, while a continuation of one of the posterior mesonephric branches of the post-caval vein extends along the inner border of the permanent kidney.

The left umbilical vein loses its opening into the ductus Cuvieri, and all its blood is taken to the liver network. The right umbilical vein, on the other hand, retains its original opening into the ductus for some time (text-fig. 90). In the subsequent changes the post-caval vein increases in size, and the part of the omphalo-mesenteric vein joining it breaks up into a venous network with the caudal extension of the liver. As the two umbilical veins are joined by an anastomosis at the navel, it is possible for the right to disappear, which it does, leaving the left, which, however, disappears soon after birth\*. Ultimately the omphalo-mesenteric vein, lying on the dorsal side of the liver, can only communicate with the sinus venosus *via* the hepatic network and the post-caval vein, which is on the ventral side of the liver.

The anterior cardinal veins originate in a similar way to those of Selachians and Amphibians, but the parts of these veins in the head are completely replaced in an interesting way (*vide* Grosser and Brezina, 19). The original cardinal vein runs backwards from the infraorbital and the anterior cerebral veins ventrally to the cranial nerves into the ductus Cuvieri. Three venous rings are now formed in succession; the first around the root of the facial nerve and the auditory vesicle, the second around the root of the glossopharyngeal nerve, and the third around the vagus root. Their median portions afterwards disappear, and the external ones unite to form one lateral trunk. In the meantime two new vessels come to open into the anterior cardinal: one, the median cerebral vein, coming from the cerebellum, opens just posterior to the trigeminal nerve; and the other, the posterior cerebral vein, coming from the medulla, opens posterior to the vagus, leaving the skull by the foramen magnum.

Still later the lateral trunk opens anteriorly into the infraorbital vein by means of an extension by the side of the second and third branches of the trigeminal nerve, and posteriorly past the hypoglossus into the anterior cardinal opposite to the posterior cerebral vein. In this way is formed a new, complete

\* Generally the umbilical vein disappears in the adult snake, but remains of it persist in some species, e. g. *Boa constrictor*, *B. divinitoqua*, *Python regius*, *Eunectes murinaus*, *Corallus cookii* (Beddard, 4 & 5).



lateral trunk, the lateral cephalic vein (V. capitis lateralis, Grosser and Brezina). At the same time the three cerebral veins become connected by a median longitudinal vessel (text-fig. 91). Further, two new anastomoses arise from the median cerebral vein, one goes to the anterior cerebral vein and the other, the secondary median cerebral vein, leaving the skull with the trigeminus, goes to the lateral cephalic vein. This becomes the main vein leading from the anterior part of the brain.

Text-fig. 91.

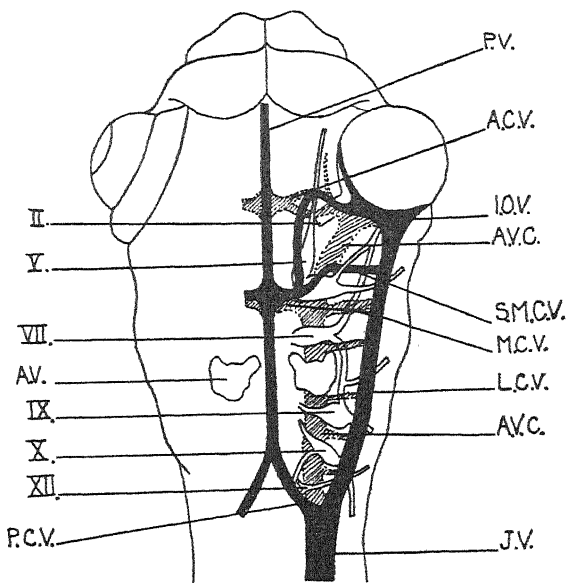


Diagram of veins in the region of the head in the embryo. It shows the original veins indicated by the shaded portions and the definitive vessels indicated in black.

A.C.V. Anterior cerebral. A.V. Auditory vesicle. A.V.C. Anterior cardinal. I.O.V. Infra-orbital. J.V. Right common jugular. L.C.V. Lateral cephalic. M.C.V. Median cerebral. P.C.V. Posterior cerebral. P.V. Prosencephalic. S.M.C.V. Secondary median cerebral. II, V, VII, IX, X, XII, Primordia of cranial nerves.

Adapted from Grosser and Brezina (19).

The adult condition is reached by the regression of the dorsal part of the anterior cerebral vein, the complete disappearance of the portion of the anterior cardinal vein in the head, leaving its cervical part, however, as the common jugular vein, and the formation of a vein bringing back blood from the upper and lower jaws.

(B) *Adult Form.*(a) *Anterior Vessels.*

The whole of the blood from the head is brought back to the heart by the two common jugular veins. The distribution of the veins in the head and their union to form the common jugulars will be dealt with later.

The *Left Common Jugular Vein*\* (V. jugularis sinister, Schlemm) runs from the anterior end of the neck parallel with and close to the left common carotid artery to the heart. It passes ventral to the left systemic arch to the dorsal side of the left auricle, and it runs along the dorso-lateral edge of this structure to the auriculo-ventricular sulcus. Here it bends sharply to the right and runs into a part of the sinus venosus somewhat sharply marked off from the remainder. It receives:—

- i. In its anterior part a few small tributaries from the anterior end of the œsophagus.
- ii. The *Coronary Veins* (text-fig. 87), a series of small vessels which join it in its course along the auriculo-ventricular sulcus.

The *Right Common Jugular Vein*\* (V. jugularis dextra, Schlemm) is similar in disposition to the left, but at the level of the anterior end of the right auricle it receives a large tributary, the azygos vein. After this it runs straight on and unites with the post-caval vein to form the major part of the sinus venosus.

I. The *Azygos Vein* (V. azygos, Schlemm) is a short trunk leading into the right common jugular vein from the union of the anterior and posterior azygos veins.

- A. The *Anterior Azygos Vein* (V. azygos anterior, Schlemm) lies in front of the heart between the œsophagus and the backbone, and extends from the beginning of the neck back to the heart. It collects blood from the dorsal body-wall along this region by means of a fairly regular series of intercostal veins, all of which come off to the right of the vertebral column. Just before it unites with the posterior azygos vein it receives a branch from the œsophagus.

- (a) The *Œsophageal Vein* is formed at the level of the front end of the thyroid gland by the union of two branches. One of these branches comes from the anterior dorsal part of the œsophagus, and the other from the posterior dorsal part. Their common stem runs almost straight to the right, ventral to the vertebral artery and dorsal to the right common jugular vein, and opens into the anterior azygos vein.

\* It is to be noted that the proximal parts of these two veins are homologous with the precaval veins of Lacertilia. As, however, there is no representative of the subclavian veins to mark the beginning of the precaval portion, it is convenient to apply the one name to the whole vessel.

- B. The *Posterior Azygos Vein* (V. Azygos posterior, Schlemm) is a much shorter vessel than the anterior, and also than the homologous vein in *Lacerta*. It originates at about the level of the middle of the ventricle, and runs forward to meet the anterior azygos just anterior to the right auricle. In its course it receives three or four intercostal veins, all of which come from the body-wall to the right of the vertebral column.

#### (h) Posterior Vessels.

The *Right Pulmonary Vein* (V. pulmonalis, Schlemm) first becomes noticeable as a definite vessel on the left side of the lung at the level of the posterior end of the liver. It runs forward along that organ to its anterior end, receiving numerous branches and, leaving the lung, it runs parallel to the post-caval vein and ventral to the right systemic arch to open into the right auricle.

A left pulmonary vein never exists at any time.

The *Caudal Vein* (V. caudalis, Schlemm) arises far back in the tail and runs forward in the hæmal canal, together with the caudal artery. It leaves this canal and divides into two branches, the renal portal veins, a short distance before reaching the cloaca.

The *Renal Portal Vein* (V. venalis advehens, Schlemm) on each side runs forward from the bifurcation of the caudal vein over the cloaca and along the outer side of each kidney. It receives soon after its origin a lateral tributary, which from its position and distribution appears to correspond to a pelvic vein\*. If this be the case, it is interesting as being the only indication in the circulatory system of the derivation of the snake from a limb-bearing ancestry. Each renal portal vein receives several small tributaries from the dorsal body-wall, the cloaca, and the lateral part of the tail. It then passes over the cloaca and lies between the oviduct which is on its outer side and the ureter which is on its inner side. Shortly after passing the cloaca each vein gives off a well-marked branch, the right being anterior to the left, which passes dorsally around the ureter and then runs ventrally to unite with its fellow on the dorsal wall of the gut. The vein so formed, the "Veine mésentérique postérieure" of Jourdain (27), runs forward along the gut and is continued as the hepatic portal vein. In its course from the cloaca to the kidney each renal portal vein receives a number of small tributaries from both ureter and oviduct, one of which, the *Posterior Oviducal Vein*, is well marked, and also one or more from the dorsal parietes. On reaching the kidney it runs along its lateral border closely accompanying the ureter, and, gradually getting smaller, disappears at the anterior end of that organ. It is not continued anterior to the kidney as in some snakes, e. g. the Boidæ and also in *Zamenis gemonensis* (Beddard, 4 & 2), a feature recalling the condition in the Lacertilia. During its course along the posterior part of the kidney this vein receives a well-marked tributary from the oviduct.

\* A similar pair of veins is to be found in *Eunectes murinus* (Beddard, 2).

The *Right Efferent Renal Vein* (V. venalis revehens, Schlemm) originates along the inner margin of the kidney at its posterior end, runs to the anterior end, and after a short independent course in front of the kidney unites with its fellow of the opposite side to give rise to the post-caval vein.

The *Left Efferent Renal Vein* also has its origin along the inner margin of the kidney. But, unlike the right, it receives branches from the supra-renal body, the ovary, and the left oviduct in its course from the kidney to the point where it unites with its fellow. Thus:—

- i. The *Left Ovarian Veins* are numerous small tributaries flowing into the left efferent renal veins.
  - ii. The *Left Supra-Renal Veins* are a large number of small branches running from the supra-renal body into the efferent renal vein, to which it is closely attached. They return the blood brought to that body by the supra-renal portal veins.
  - iii. The *Left Oviducal Vein* is a large vein leaving the oviduct at the level of the fimbriated funnel and flowing into the efferent renal vein just in front of the supra-renal body. It returns blood from the oviducal sinus.
- A. The *Left Oviducal Sinus* is a wide thin-walled vessel which runs from the extreme anterior end of the oviducal funnel backwards to about the level of the middle of the corresponding kidney. It is very conspicuous in injected specimens and was present in all the female examples of *T. natrix* that I have examined, although it does not appear to have been recorded in any other Ophidian.

The *Post-Caval Vein* (V. cava posterior, Schlemm) is formed, as has been stated above, by the union of the two efferent renal veins. It passes forward, dorsal to the gut, freely in the mesentery to the posterior extremity of the liver, and then along in a groove in the ventral surface of that organ to its anterior end. After leaving the liver it runs almost straight forward, ventral to the right systemic arch and unites with the right pre-caval to form the larger division of the sinus venosus. Soon after its origin it receives veins from the right ovary, the supra-renal body, and the oviduct. Thus:—

- i. The *Right Ovarian Veins* are similar to those of the opposite side.
  - ii. The *Right Supra-Renal Veins* also resemble those on the left and return the blood gathered by the supra-renal portal veins.
  - iii. The *Right Oviducal Vein* is like its fellow on the left and comes from an oviducal sinus.
- A. The *Right Oviducal Sinus* extends along the oviduct from the anterior end of the funnel to about the level of the middle of the right kidney.

The *Supra-renal Portal System*.—Each supra-renal body has a portal supply, an arrangement of vessels which is universally present in snakes according to Beddard (1), who, however, attributes the discovery of this system to Gratioulet in 1853 (17), whereas it had been described seven years previously by Ecker (15). The supply consists of two, but in more rare cases of three, intercostal veins which arise from the corresponding side of the dorsal body-wall and also of a vessel from the oviductal sinus in the female, all of these pour their blood into the supra-renal network. The last of these vessels is rather small and runs at the level of the middle of the ovary on each side.

The *Hepatic Portal Vein* (Vena portæ, Schlemm) arises by two roots, from the renal portal veins, which unite to form a single vessel on the dorsal wall of the rectum in a way that has already been described\*. It passes forward through the gut mesentery, receiving on its way numerous branches from the many coils of the small intestine and also from the fat-body. Towards its anterior end a tributary joins it bringing blood from the front part of the intestine, the pancreas, and the spleen. This is shortly followed by another vein coming from the gall-bladder. In the same region it is joined by the anterior abdominal vein which runs down from the fat-body. From this point instead of being on the ventral side of the post-caval vein it passes dorsally to the left of this vessel and enters a furrow on the dorsal side of the liver. Between the entrance of the vein from the pancreas and the spleen and the posterior end of the liver, *i. e.* just anterior to the superior mesenteric artery, the hepatic portal vein receives three large intercostal veins from the parietes of the right side. The vessel runs in the groove of the liver right to its anterior end, gradually diminishing in calibre, and it receives in this part of its course a more or less regular series of intercostal veins arising to the left of the vertebral column and a greater number of small veins from the stomach and œsophagus. A very similar condition obtains in *T. fasciatus* (Beddard, 1).

I. The *Anterior Abdominal Vein*†, corresponding to the similarly-named vein in Lacertilia, is a single small vein arising at

\* According to Schlemm (35) the hepatic portal vein has only one root, and that arises from the right renal portal vein. This statement is also made in Hoffmann (23), but it should be noted that this author quotes nearly the whole of Schlemm's account of the venous system almost verbatim without indicating in any way that he is so doing. My own investigations confirm those of Jourdain (27) and Hochstetter (20), who describe a double root for this vein in *Tropidonotus*, one part arising from each renal portal vein. The latter author makes a similar statement with regard to *Coluber ascalapii*. Beddard (4 & 3) has also recorded the same arrangement in *Coluber corais*, *Zamenis gemonensis*, and *Ancistrodon piscivorus*. According to Jaquet (26) there are a number of anastomoses between the hepatic portal vein and the right renal portal vein in *Python*. In Gadow's account of *Pelophilus madagascariensis*, quoted by Hoffmann (23), it is stated that there is no connection between the hepatic portal and renal portal veins.

† This vein is especially interesting, as it is subject to considerable variation among the Ophidia. In Lizards, as is well known, it arises by two roots from the renal portal veins, and a similar condition is to be found in some snakes, *viz.* *Eryx jaculus*, *E. johii*, *Python sebae*, and *Boa diviniogum*, Beddard (2, 3, & 4). In other snakes

the posterior end of the fat-body and running forward in it to the level of the spleen, where it passes dorsally and opens into the hepatic portal vein. It is only connected in an indirect way by small anastomosing branches with the renal portal veins. Along its course it receives little twigs from the epigastric vein.

The *Epigastric Vein* lies beside the epigastric artery in the mid-ventral line of the abdominal wall. In the region of the liver it gives off five or six small branches, all of which enter directly into the left side of that body and are not connected with the hepatic portal vein. Behind the liver the epigastric vein is connected by a number of small venules with the anterior abdominal vein. As Beddard (4) has pointed out, this is one of the most constant veins in Snakes, and is single save in *Lioheterodon maculagascariensis*, where it is alternately single and double.

The veins in the male are, like the arteries, on the whole very similar to those in the female. Those in front of the heart are precisely similar in both sexes.

The caudal vein bifurcates to form the renal portal veins which, at the level of the cloaca, receive the paired pelvic veins, and in addition, in the male a vein from each corpus cavernosum. The renal portals give rise to the two branches which unite above the gut to form the beginning of the hepatic portal vein and then pass forwards to the kidneys between the vasa deferentia and the ureters. On the kidney they receive no specially marked tributary from the vas deferens to correspond with the one from the oviduct in the female.

Each testis gives off one spermatic vein, whereas in the female there are a number of small ovarian veins, just in front of the corresponding supra-renal body, that of the left side opening into the left efferent renal vein, and that of the right into the post-caudal vein.

There is no vessel in the male to correspond with the oviducal sinus, and consequently no branch from it to the supra-renal body. The supra-renal portal supply consists of two intercostal veins, one at each end of that body, which arise from the corresponding side of the vertebral column.

Some variation is to be met with in the position of the union of the two efferent renal veins with regard to the kidneys. The junction may be as much as an inch in front of the right kidney, or, on the other hand, this kidney may overlap the point of union, in which case several small veins bring back the blood from the

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it has only a single origin from the left renal portal vein, viz., *Eryx conicus*, *Ennecetes marinus*, and *E. nobilis*, Beddard (8). Lastly, it may have no direct connection with the renal portal veins, but only indirect ones by means of anastomosing twigs, viz., *Zamenis gemmonensis*, Beddard (2), *Coluber esculi*, and *Tropidonotus natrix*, Hoelstetter (20). This last observation I have been able to confirm. Further, the anterior abdominal vein may be partly double throughout, as in *Boa constrictor*, *B. diadelpus*, *Eryx jaculus*, Beddard (4), and *Python seba*, Jaquart (26), or single as in *Zamenis gemmonensis*, *Causus rhombeatus*, *Eryx johni*, Beddard (2), and *Tropidonotus natrix*.

anterior end of the kidney into the right efferent renal vein. On the whole this distance appears to be greater in the female than in the male.

The remaining vessels of the male, the hepatic portal factors, the anterior abdominal vein, and the epigastric vein correspond in all respects to those of the female.

## V. THE VESSELS OF THE HEAD. (Pls. LXXI. & LXXII.)

### (A) *Arteries.*

It has been pointed out above that the whole of the blood is brought to the head by the left common carotid, the right common carotid having disappeared early in the course of development. To compensate for this absence of an artery on the right side we find developed three arterial anastomoses between the two sides of the head. The first lies beneath the medulla oblongata and joins the two internal carotids; the second is situated beneath the fore-brain just in front of the optic chiasma and unites the anterior cerebral and facial carotids; and the third is behind the symphysis of the lower jaw and joins the two external carotids.

The *Left External Carotid* (Carotis externa, Rathke; Arteria inframaxillaris, Schlemm) arises from the common carotid internal to the articulation of the lower jaw and the quadrate bone. It runs forward between the floor of the pharynx and the broad mylohyoides\* muscle, first inwards towards the tongue sheath and then outwards to the inner side of the mandible, being accompanied throughout the greater part of its course by its corresponding vein, the glossopharyngeal nerve, and the cutaneous branch of the hypoglossal nerve. At the anterior end of the lower jaw, just a short distance behind the symphysis, the left external carotid anastomoses with its fellow by a well-marked vessel.

The *Right External Carotid* is similar to the left, save that the common carotid from which it originated has disappeared and is represented only by a small branch vessel. It receives its blood-supply partly from the anastomosis just mentioned, and partly from the anastomosis between the internal carotids.

The distribution of the arteries in the dorsal part of the head is the same on both sides, so that the one description will apply equally well to either side.

The *Internal Carotid* (Carotis interna, Rathke; Art. cephalica and Art. carotis communis, Schlemm) starts from the origin of the external carotid and bends in a sharp curve dorsally round the angle of the lower jaw on the inner side of the vagus and hypoglossal nerves. It then passes forward under the columella and along the inner side of the quadrate to a point behind the orbit and above the posterior pterygo-sphenoidalis muscle, where

\* The nomenclature of the muscles is that adopted by Hoffmann (23).

it divides into two branches, the cerebral carotid and facial carotid arteries.

During this course it gives off the following branches :—

I. One well marked and sometimes also a smaller artery that supply the œsophagus.

II. A branch that supplies a part of the cervico-mandibularis muscle, the lateral and ventral walls of the pharynx and skin in this region.

III. A branch (*Ramus pterygoideus*, Schlemm) which supplies the transverso-maxillo-ptyerygo-mandibularis, and the cervico-mandibularis muscles and the skin near them.

IV. The *First Spinal Artery* (*Ramus spinalis*, Rathke; *Art. nervi spinalis I*, Hofmann) which arises at the same level or slightly in front of the preceding. The vessel passes through the atlanto-occipital membrane between the axis and the basi-occipital bone and, running into the loop of the basilar artery beneath the medulla oblongata, forms an anastomosis with its fellow of the opposite side, a relationship first described by Schlemm (35), who called this vessel the *Truncus anonymus*. By means of this anastomosis the blood can pass from the left to the right internal carotid. Shortly before piercing the atlanto-occipital membrane this artery gives off two branches :—

A. A small branch (*Ramus pterygoideus*, Schlemm) to the Pterygo-sphenoidalis muscles.

B. A fairly large *Occipital artery* (*Art. occipitalis*, Schlemm), which however soon divides into two vessels, a small and a large.

The smaller is the occipital branch (*Ramus occipitalis*, Schlemm), supplying the muscles and skin of the occipital region.

The larger is the *Cervical Artery* (*Art. cervicalis*, Schlemm), a long and fairly well-marked vessel. It runs backwards near the hypapophyses of the anterior vertebrae, covered by the rectus capitis anticus muscles to which it sends small branches, to the fourteenth vertebra. Here it joins with a small branch from the bifurcated extremity of the vertebral artery. During its course it gives off a series of branches that lie beside the spinal nerves, and each of these sends branches not only to the skin and muscles, but also a small one, a spinal artery, that enters the neural canal through the intervertebral foramen.

V. The *Maxillary Artery* (*Art. maxillaris*, or *dentalis inferior*, Rathke; *Art. alveolaris inferior*, Schlemm) arises about midway between the spinal artery and the point just behind the orbit where the internal carotid divides. It runs outwards, accompanying the inferior maxillary branch of the trigeminal nerve between the second and third parts of the parietali-quadrato-mandibularis muscle, to which it gives branches. After giving off several twigs also to the transverso-maxillo-ptyerygo-mandibularis muscle, it passes on through the posterior maxillary foramen into the lower



jaw. It soon gives off a branch to the inferior labial gland\*, and then runs on in the lower jaw to its anterior end. Here it comes out through the anterior maxillary foramen as the *Mentalis Artery* (Art. mentalis, Rathke) and supplies the anterior part of the inferior labial gland and the skin in the region of the chin.

Just anterior to this branch the internal carotid splits into two branches, the cerebral carotid and the facial carotid arteries.

The *Cerebral Carotid* (Art. carotis cerebialis, Rathke and Hofmann) is a vessel of moderate calibre running downwards just behind the infra-maxillary branch of the trigeminal nerve. It then turns inwards under the skull and enters the cranial cavity through a foramen in the basisphenoid. This vessel was overlooked by Schlemm. In its course it gives off a small artery just outside the skull going to the posterior pterygo-sphenoidalis muscle. Inside the skull near the hinder end of the pituitary fossa it splits into three fairly equal vessels, the posterior, median, and anterior cerebral carotids.

I. The posterior branch (Ramus caudalis, Hofmann) runs backwards round the outside of the pituitary fossa, giving off branches to the cerebellum and, about half-way to the foramen magnum, unites with the similar vessel of the other side to form the median basilar artery.

The *Basilar Artery* (Art. basilaris, Rathke and Hofmann) passes backwards until just before the foramen magnum, where it splits up into a loop in the form of an isosceles triangle. Into the corners of the base of this loop open the right and left first spinal arteries, and thus it forms the anastomosis between these two vessels. Before it divides to form the loop, the basilar artery gives off on either side a well-marked internal auditory artery (Art. auditiva interna, Rathke and Hofmann) that enters the ear with the auditory nerve, and also a series of smaller branches, some of which supply the medulla, and some run on to the small choroid plexus of the fourth ventricle.

II. The median branch† runs outwards behind the cerebral hemisphere, to which it gives some twigs, and a short distance from its origin divides into two.

A. The *Anterior Choroid Artery* (Art. choroïdes anterior, Hofmann) is the anterior branch. It passes around the hemispheres, supplying them with small twigs, to the dorsal side of the brain near the pineal stalk, where it breaks up in the choroid plexus of the third and lateral ventricles and anastomoses with a branch from the olfactory artery.

B. The posterior division passes behind the optic lobes and spreads itself out over their dorsal surface.

\* The nomenclature of these glands in the head of the snake is that given by West (37 & 38).

† In some examples this median branch does not arise at the point where the cerebral carotid splits into anterior and posterior branches, but a little way down the latter; consequently it appears as a branch of the posterior cerebral carotid and is described as such by Hofmann (24).

III. The anterior branch (*Ramus cranialis*, Hofmann) runs forward along the side of the pituitary fossa and unites with the similar vessel from the other side under the bases of the optic nerves immediately in front of the chiasma. By the union of the two anterior and the two posterior branches of the cerebral carotids a complete arterial ring, the circle of Willis (*circulus arteriosus cerebialis*, Hofmann) is formed around the pituitary fossa. During its course this anterior branch gives off:—

- A. A *Median Cerebral Artery* (*Art. cerebri media*, Hofmann), which is a large vessel running round to the dorsal side of the brain and supplying the anterior end of the hemispheres and the olfactory lobes.
- B. An *Ophthalmic Artery* (*Art. ophthalmica*, Hofmann), which is given off immediately before the two anterior branches of the cerebral carotids unite to form the circle of Willis. This passes out of the skull with the optic nerve, and immediately on reaching the orbit anastomoses with a branch of the facial carotid.

The *Olfactory Artery*\* (*Art. olfactoria*, Schlemm) arises from the mid-point of the anastomosis of the two anterior branches of the cerebral carotids and runs forward in the skull in the furrow between the two olfactory lobes, to which it sends branches. At the anterior end of the lobes it gives off two symmetrical branches. Each of these again divides into two (*Aa. ethmoidales*, Rathke; *Aa. bulbi olfactorii mediales*, Hofmann), which pass out of the skull with the olfactory nerve to ramify over the olfactory membrane. The main trunk then recurves dorsally and runs back in the fissure between the two hemispheres, to which it sends numerous small branches, and near the pineal body anastomoses on each side with a branch of the anterior division of the median branch of the cerebral artery.

The *Inferior Spinal Artery* (*Art. spinalis inferior*, Rathke; *Tractus spinalis ventralis*, Hofmann) is situated just below the ventral fissure of the spinal cord, and runs in a fairly straight line caudally from the anastomosis between the right and left first spinal arteries at the posterior end of the basilar artery. On its course it gives off branches to the spinal cord, some of which pass around to the dorsal side and others enter the ventral fissure, and it also receives the paired spinal arteries which come in through the vertebral column at the points of exit of the spinal nerves. In some places where a pair of such arteries enter it, the inferior spinal artery splits into a diamond-shaped loop.

The *Facial Carotid* (*Carotis facialis*, Rathke) takes a fairly straight course forward through the temporal fossa close to the infra-maxillary branch of the trigeminal nerve to the orbit. Here it passes under the post-frontal bone into the orbit and

\* This artery is double for the greater part of its length in *Python molurus*, Beddard (6).

immediately divides into two fairly equisized terminal branches. On its way it gives off:—

I. A branch (*Ramus glandulae maxillae superioris posterior*, Schlemm) which arises a short distance behind the orbit and runs outwards to the posterior part of the parotid gland, *i. e.*, the gland corresponding to the poison-gland of other snakes. It ramifies in the gland, and one of its branches anastomoses with a branch of the artery supplying the anterior part of the gland. During its course it gives off a palatine branch and branches to several muscles.

II. Several small branches and one fairly well-marked one that supply the Harderian gland.

III. Two or three slender branches to the skin overlying the skull and one or two to the under side of the skull.

One terminal branch (*Carotis facialis*, Schlemm) of the facial carotid passes along the back of the orbit downwards to its floor, where it runs forward (*Ramus palatinus anterior*, Schlemm), accompanying the infra-orbital branch of the trigeminal nerve. It goes on forward out of the orbit, close to the outer wall of the internal nares, and finally spreads out over the skin and muscles at the front end of the snout. During its course it gives off:—

I. A well-marked vessel (*Ramus glandulae maxillaris superioris anterior*, Schlemm) that accompanies the supra-maxillary branch of the trigeminal nerve outwards in the posterior wall of the orbit and along the upper jaw. It supplies the teeth in the posterior part of the upper jaw, the superior labial gland, the anterior part of the parotid gland, within which one of its small twigs anastomoses with a similar twig from the artery supplying the posterior part of this gland, and finally it gives off small vessels to the skin in this region.

II. A posterior palatine branch (*Ramus palatinus recurrens*, Schlemm) that goes to the posterior palatine teeth.

III. Small branches to the anterior palatine teeth.

IV. Branches to the teeth in the anterior end of the jaw.

V. Branches to the nasal gland.

The other slightly stouter terminal branch of the facial carotid artery (*Art. carotis cerebialis*, Schlemm) runs in an irregular arch along the upper, inner, and hinder sides of the orbit to the optic foramen, where it anastomoses with the ophthalmic artery. In this way the blood from the left facial carotid can pass *via* the ophthalmic artery into the circle of Willis, and thence to the encephalic arteries and also over into the right facial carotid. In its course this artery sends out the following branches:—

I. Several well-marked twigs to the part of the Harderian gland within the orbit.

II. Branches to the muscles of the eye (*Aa. musculares oculi*, Rathke).

III. Two short ciliary branches (*Aa. ciliares postice breves*, Rathke).

IV. Two longer ciliary branches (Aa. ciliares posticae longae, Rathke), one of which runs forward on the inner side of the eye and the other outward on its hinder side.

V. A *Retinal Artery* (Art. centralis retinae, Rathke) which enters the eyeball with the optic nerve and spreads out over the retina.

### (B) Veins.

The veins of the head of *Tropidonotus natrix* have recently been described in great detail by Bruner (12), who also describes a muscular mechanism in the head whereby the blood-pressure in its veins and sinuses may be considerably increased. It is not possible by ordinary dissection to make out all the small vessels given by that author, and, as my own results agree closely with his, it will only be necessary, for the sake of completeness, to give a brief description of the cephalic veins.

The *Mandibular Vein* (V. inframaxillaris, Schlemm; V. mandibularis, Bruner) arises from a small sinus at the anterior end of the lower jaw and runs backwards close to and on the outer side of the external carotid artery. On its way it receives veins from the trachea, tongue-sheath, muscles of the floor of the mouth, and the pharynx. It runs into the maxillary vein immediately before the latter joins with the lateral cephalic vein to form the common jugular vein. The bases of the mandibular, maxillary, and lateral cephalic veins and the anterior end of the common jugular vein are surrounded by constrictor muscles whose morphology and function are described by Bruner (*loc. cit.*).

The *Maxillary Vein* (V. palatina, Schlemm; V. maxillaris, Bruner) also commences in a small sinus which is situated just behind the premaxilla. This sinus has a double anastomosis with the similar one on the other side. From this point it runs backwards beneath the nasal cavity along the floor of the orbit and then above the palate to join the mandibular vein at the angle of the lower jaw. During its course it receives:—

I. The *Rostral Vein* (V. rostralis, Bruner), which enters at the level of the anterior anastomosis and brings the blood from a venous network at the front end of the snout. It also receives nasal veins (V. nasales externæ, dorsalis, and ventralis, Bruner) from the nasal gland.

II. The *Subnasal Vein* (Sinus subnasalis, Bruner), which enters at the level of the posterior anastomosis. It drains a somewhat complex system of subnasal sinuses, which anastomose with one another at the posterior end of the nasal cavity and which receive also the palato-pterygoid vein.

The *Palato-pterygoid Vein* (Sinus palato-pterygoideus, Bruner) runs from near the anterior to near the posterior end of the skull on the inner side of the palatine and pterygoid bones, and flows into the anastomosis between the subnasal sinuses.

III. A vein that joins it at the anterior end of the orbit and forms an anastomosis between it and the orbital sinus.

IV. An *Inferior Palpebral Vein* (V. palpebralis inferior, Bruner) that also enters at the front end of the orbit and runs backwards in the lower eyelid to its posterior end, where it enters the orbital sinus together with the superior palpebral vein.

V. Several small veins from the orbital sinus just posterior to the orbit.

VI. An *Oblique Palatine Vein* (V. palatina obliqua, Bruner) that runs obliquely forward beneath the skull at the level of the hypophysis to join the similar vessel of the opposite side and form a median palatine sinus which runs forward for a short distance. Before reaching the middle line it gives off a palato-cerebral vein.

The *Palato-cerebral Vein* (V. palato-cerebrales, Bruner) runs dorsally around the skull and enters the median cerebral vein soon after this leaves the cranium.

The *Orbital Sinus* (Sinus orbitalis, Bruner) is a fairly large well-defined sinus occupying the inner and hinder parts of the orbit. At the outer end of the hinder part it is prolonged outside the orbit beneath the Harderian gland. It receives the following branches :—

I. A small vein at its anterior end which comes from the nasal gland.

II. The vein joining it to the maxillary vein which also enters at the anterior end.

III. The *Superior Palpebral Vein* (V. palpebralis superior, Bruner), which arises at the anterior end of the sinus and runs backwards in the upper eyelid, re-entering the sinus at its posterior end and receiving just before it does so the inferior palpebral vein.

IV. The *Secondary Anterior Cerebral Vein* (Sekundäre Verbindung der v. cerebialis media mit der v. cerebialis anterior, Grosser und Brezina) which runs from the posterior internal corner of the orbital sinus backwards inside the skull into the median cerebral vein just as the latter is leaving the cranial cavity. The anterior segment of this vessel is formed by a part of the original anterior cerebral vein.

The *Lateral Cephalic Vein* (V. capitis lateralis, Grosser und Brezina; V. jugularis interna, Bruner) arises from the posterior prolongation of the orbital sinus and runs inwards and backwards to the side of the internal carotid artery. It passes backward closely accompanying this artery to the posterior end of the head, where it bends round to the ventral side and unites with the maxillary and mandibular veins to form the common jugular vein. On its course it receives :—

I. A vein from the Harderian gland.

II. The *Median Cerebral Vein* (V. cerebialis media, Bruner).—This runs from the longitudinal cerebral vein on the dorsal side

of the brain, outwards, and around the posterior face of the optic lobes to the ventral side of the brain. Here it goes forward and leaves the skull by the foramen for the trigeminal nerve. Outside the skull it bends sharply backwards and joins the lateral cephalic vein as the latter reaches the internal carotid artery. The last part of this vessel outside the skull is a secondary connection (*V. cerebialis media secundaria*, Grosser and Brezina) developed between the median cerebral vein, which originally opened into the internal jugular, and the lateral cephalic vein. During its course it receives:—

- A. The *Dorsal Cephalic Vein* (*V. capitis dorsalis*, Bruner), which arises from its dorsal side within the skull and passes outward through a special foramen. It runs backwards between the pro-otic and squamosal bones, receiving one or two cutaneous veins, and then bends laterally and enters the lateral cephalic vein.
- B. The *Secondary Anterior Cerebral Vein*, which runs on the floor of the cranium and joins it to the orbital sinus (*vide supra*).
- C. The *Palato-cerebral Vein*, which connects it with the oblique palatine vein (*vide supra*). According to Bruner there is also an external secondary anastomosis with the anterior cerebral vein, as well as the internal one described above. I have been unable to find this vein by dissection.

III. A large vein from the parotid gland and the muscles of the head, which closely accompanies the maxillary artery and enters the lateral cephalic vein close to the place where the maxillary artery leaves the internal carotid.

IV. A *Dorsal Cephalic Vein* (*vide supra*), which joins it to the median cerebral vein.

V. The *Posterior Cerebral Vein* (*V. cerebialis posterior*, Bruner), which runs from the end of the longitudinal cerebral vein a little behind the posterior end of the optic lobes obliquely outwards over the medulla oblongata and leaves the skull by the foramen magnum. Just before leaving the cranium it gives off a *Spinal vein* which runs caudally on the ventral side of the spinal cord, where it unites with the similar vessel from the other side.

VI. One well-marked and several smaller veins from the muscles of the posterior end of the skull.

VII. A *Cervical vein* which returns blood from the muscles of the neck.

The *Longitudinal Cerebral Vein* (*V. longitudinis cerebri*, Bruner) is a vessel running backwards along the mid-dorsal aspect of the brain from between the olfactory lobes. At the posterior end of the optic lobes it gives off the median cerebral veins, and a short distance further back divides to form the posterior cerebral veins.

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## VII. EXPLANATION OF PLATES LXX.-LXXII.

*Lettering.*

- |  |                                       |
|--|---------------------------------------|
| A.A.L. Left Aortic Arch.               | G.A. Gastric Artery.                  |
| A.A.R. Right Aortic Arch.              | <i>Gall. Bl.</i> Gall-bladder.        |
| A.A.V. Anterior Abdominal Vein.        | H.A. Hepatic Artery.                  |
| A.C.A. Anterior Choroid Artery.        | <i>Har. Gl.</i> Harderian Gland.      |
| A.V. Azygos Vein.                      | H.G.A. Harderian Gland Artery.        |
| A.V.A. Anterior Azygos Vein.           | H.P.V. Hepatic Portal Vein.           |
| A.V.P. Posterior Azygos Vein.          | H.P.V.' The posterior part of the     |
| B.A. Basilar Artery.                   | Hepatic Portal Vein, the              |
| B.A.L. Loop of Basilar Artery.         | "Veine mésentérique                   |
| C.A. Left Common Carotid               | postérieure" of Jourdain              |
| Artery.                                | (27).                                 |
| Ca. A. Caudal Artery.                  | H.P.V.O. Origin of the Hepatic Portal |
| C.C.A. Cerebral Carotid Artery.        | Vein from the Renal Portal            |
| C.C.Ant. Anterior branch of the        | Vein.                                 |
| Cerebral Carotid Artery.               | I.A.A. Internal Auditory Artery.      |
| C.C.M. Median branch of the            | I.C.A. Internal Carotid Artery.       |
| Cerebral Carotid Artery.               | I.C.M. Muscular branch of In-         |
| C.C.P. Posterior branch of the         | ternal Carotid Artery.                |
| Cerebral Carotid Artery.               | I.C.O. (Esophageal branch of In-      |
| Cep. V.D. Dorsal Cephalic Vein.        | ternal Carotid Artery.                |
| Cep. V.L. Longitudinal Cephalic        | I.M.A. First Inferior Mesenteric      |
| Vein.                                  | Artery.                               |
| Cer. A. Cervical Artery.               | I.M.A.2. Second Inferior Mesenteric   |
| Cer. V. Cervical Vein.                 | Artery.                               |
| <i>Cer. Hem.</i> Cerebral Hemispheres. | I.M.A.3. Third Inferior Mesenteric    |
| C.W. Circle of Willis.                 | Artery.                               |
| C.J.L. Left Common Jugular             | I.M.A.4. Fourth Inferior Mesenteric   |
| Vein.                                  | Artery.                               |
| C.J.R. Right Common Jugular            | <i>Inf.</i> Infundibulum.             |
| Vein.                                  | I.P.V. Inferior Palpebral Vein.       |
| C.V. Caudal Vein.                      | I.S.A. Inferior Spinal Artery.        |
| C.V.L. Longitudinal Cerebral           | <i>Kid. L.</i> Left Kidney.           |
| Vein.                                  | <i>Kid. R.</i> Right Kidney.          |
| C.V.M. Median Cerebral Vein.           | L.A. Left Auricle.                    |
| C.V.P. Posterior Cerebral Vein.        | L.C.A. Long Ciliary Artery.           |
| C.V.S.A. Secondary Anterior Cere-      | L.G.A. Lienogastic Artery.            |
| bral Vein.                             | L.R.A. Anterior Left Renal            |
| D.A. Dorsal Aorta.                     | Artery.                               |
| E.C.A. Anastomosis of the two Ex-      | L.R.M. Median Left Renal Artery.      |
| ternal Carotid Arteries.               | L.R.P. Posterior Left Renal           |
| E.C.L. Left External Carotid           | Artery.                               |
| Artery.                                | M.A. Maxillary Artery.                |
| E.C.R. Right External Carotid          | M.C.A. Median Cerebral Artery.        |
| Artery.                                | M.C.P. Posterior branch of the        |
| E.M.A. Eye Muscle Artery.              | Median branch of Cere-                |
| E.R.L. Left Efferent Renal Vein.       | bral Carotid Artery.                  |
| E.R.R. Right Efferent Renal Vein.      | <i>Med.</i> Medulla oblongata.        |
| <i>Est. Nar.</i> External Nares.       | M.V. Mandibular Vein.                 |
| F.A. Fat-body Artery.                  | Mx. Maxillary Vein.                   |
| F.C.A. Facial Carotid Artery.          | Mx.A. The double anastomosis of       |
| F.C.P. Palatine branch of the          | the Maxillary Vein.                   |
| Facial Carotid Artery.                 | O.A.L. Left Ovarian Artery.           |

O.A.R. Right Ovarian Artery.	Pel. V. Vein probably corresponding to the Pelvic Vein of Lacertilia.
Oc. A. Occipital Artery.	<i>Pit. Fos.</i> Pituitary Fossa.
Od. A. Oviducal Artery.	Pl. C.V. Palato-cerebral Vein.
Od. A.P. Posterior Oviducal Artery.	Pl. P.V. Palato-pterygoid Vein.
Od. S.L. Left Oviducal Sinus.	Pul. A. Pulmonary Artery.
Od. S.R. Right Oviducal Sinus.	Pul. V. Pulmonary Vein.
Od. V.L. Left Oviducal Vein.	P.V. Parietal Vein.
Od. V.L.P. Left Posterior Oviducal Vein.	R.A. Right Atricle.
Od. V.R. Right Oviducal Vein.	Ret. A. Retinal Artery.
Od. V.R.R. Right Posterior Oviducal Vein.	R.P.L. Left Renal Portal Vein.
Oe. A. Oesophageal Artery.	R.P.R. Right Renal Portal Vein.
Oe. V. Oesophageal Vein.	R.R.A. Anterior Right Renal Artery.
Ol. A. Olfactory Artery.	R.R.M. Median Right Renal Artery.
<i>Off. lo.</i> Olfactory Lobe.	R.R.P. Posterior Right Renal Artery.
Op. A. Ophthalmic Artery.	Rt. A. Rectal Artery.
<i>Opt. lo.</i> Optic Lobe.	R.V. Rostral Vein.
<i>Opt. Ner.</i> Optic Nerve.	S.C.A. Short Ciliary Artery.
O.P.V. Oblique Palatine Vein.	S.M.A. Superior Mesenteric Artery.
<i>Orb.</i> Orbit.	S.N.A. Anastomosis of the Sub-nasal Sinuses.
O.S. Orbital Sinus.	S.N.V. Sub-nasal Vein.
O.S.A. Anastomosis between the Orbital Sinus and the Maxillary Vein.	Sp. A. First Spinal Artery.
Ov. A. Smaller Ovarian Artery.	Sp. V. Spinal Vein.
<i>Ovar. L.</i> Left Ovary.	<i>Spin. Cor.</i> Spinal Cord.
<i>Ovar. R.</i> Right Ovary.	<i>Spl.</i> Spleen.
P.A. Parietal Artery.	S.P.L. Left Supra-renal Portal Vein.
<i>Pan.</i> Pancreas.	S.P.R. Right Supra-renal Portal Vein.
<i>Par.</i> Parotid Gland.	S.R.L. Left Supra-renal Vein.
Par. A. Anastomosis between a branch of the Anterior and a branch of the Posterior Parotid Gland Arteries.	S.R.R. Right Supra-renal Vein.
Par. A.A. Anterior Parotid Gland Artery.	<i>Sup. Lab. Gt.</i> Superior Labial Gland.
Par. P.A. Posterior Parotid Gland and Superior Maxillary Artery.	<i>Sup. Ren. L.</i> Left Supra-renal body.
Par. V. Vein from Parotid Gland and also from neighbouring muscles.	<i>Sup. Ren. R.</i> Right Supra-renal body.
P.C. Primary Carotid Artery.	Th. A. Thyroid Artery.
P.C.V. Post-Caval Vein.	<i>Thy. Gt.</i> Thyroid Gland.
	<i>Ton. Mus.</i> Tongue Muscle.
	<i>Ton. Sh.</i> Tongue Sheath.
	V. Ventricle.
	V.A. Vertebral Artery.

## PLATE LXX.

Fig. 1. Diagram of the Heart and Blood-vessels in the anterior part of *Tropidonotus natrix*. The two main arteries and veins on the ventral side of the head are indicated, but their precise distribution is dealt with on Plate LXXII. Between the lines X.X. and Y.Y. a portion of the circulatory system is omitted, as the relations of the Hepatic and Pulmonary Vessels and the Dorsal Aorta are similar throughout the whole length of the liver. The part omitted is about the same length as the distance from the thyroid gland to the line X.X. For the purposes of diagram the liver is represented as pulled out to the right of the animal. The positions of the Liver and Lungs are indicated by simple outline and those of the Gall-bladder, Spleen, and Pancreas by shaded areas.

Fig. 2. Diagram of the posterior Blood-vessels in a female *Tropidonotus natrix*. The positions of the kidneys and ovaries are indicated by simple outline and those of the supra-renal bodies by shaded areas. For the purposes of diagram the intestine is represented as pulled out to the right of the animal, the fat-bodies as external to the oviducts, and the oviducts as external to the ureters. Owing to the fact that the anterior end of the Fat-body is supplied from the right ovarian artery, while a little further

back it is fed from the left ovarian artery, it is necessary to divide the Fat-body between the two gonads. Thus it comes that the anterior part of the Fat-body is represented on the right side of the animal and the posterior part on the left. As the Anterior Abdominal Vein runs in the Fat-body it is also divided and is so represented in the diagram, in which its two ends are joined by a dotted line.

## PLATE LXXI.

Diagrams of the Blood-vessels in the head of *Tropidonotus natrix*.

- Fig. 3. Diagram of the Cranial Arteries seen on the ventral surface of the brain. The brain is represented as removed from the skull leaving behind, however, the Pituitary Body.
- Fig. 4. Diagram of the arteries of the head seen from the dorsal side. The brain is removed, but some of the cranial arteries are left behind. The positions of the glands of the head are indicated by shaded areas.

## PLATE LXXII.

- Fig. 5. Diagram of the vessels on the ventral side of the lower jaw after the removal of the superficial muscles.
- Fig. 6. Diagram of the Veins and Sinuses in the head seen from the dorsal side. The deeper vessels are represented in lighter shading and with a dotted outline. The position of the brain is indicated in simple outline, while the positions of the glands are indicated by shaded areas. For the purposes of diagram the Superior Palpebral Vein is omitted. It runs from the upper anterior part of the Orbital Sinus above the Maxillary Vein and joins the Inferior Palpebral Vein as the latter enters the Orbital Sinus. In dissecting out the vessels of the orbit it is almost always removed with the upper eyelid.

### 34. A First Account of the Courtship of the Redshank (*Totanus calidris* L.). By JULIAN S. HUXLEY, Lecturer of Balliol College, Oxford.

[Received February 2, 1912: Read April 23, 1912.]

## INDEX.

	Page
1. Introduction .....	647
2. Locality .....	648
3. The Courtship proper .....	649
4. Other habits of the Pairing-Season :	
(a) The Love-flight .....	651
(b) The Combats of the Males .....	652
(c) Calling from a conspicuous perch .....	652
5. Discussion .....	652

## I. INTRODUCTION.

While staying last spring in a lonely corner of North Wales it was my good fortune to come across a number of rare and interesting birds. But great as was the pleasure of seeing, for the first time, such comparatively uncommon species as the Grey Plover and Black-tailed Godwit, it was far surpassed by that of being able to study, under the most favourable conditions, the natural behaviour and home life of some of the commoner shore-birds. Of these I was particularly fortunate with the Redshank,

and was able to see the whole of the courtship and pairing. When I say the whole, I do not mean that I saw every detail, nor that every detail I saw is clear to me. But I mean that I know what is the general course of events, and can interpret the birds' behaviour more or less consistently.

On returning to civilization and libraries, to my surprise I could find very little on the subject: the observations recorded were either fragmentary or inaccurate. It was not until most of this paper was written that I discovered a fairly complete account by Selous\*. This had remained undiscovered owing to the absence of any reference to Redshanks in the title of the paper or in the index of the volume.

I have thought it worth while to publish my observations, however, since they differ in several points from those of Selous. Meanwhile, I fully realize their incompleteness, and recognize that they cannot as yet be properly used in any general discussion of the theory of sexual selection. I hope to continue my own observations when opportunity offers, but venture to publish this general outline at once as a stimulus to other bird-watchers and naturalists.

## 2. LOCALITY, etc.

Before passing on to the birds' actions I must first just mention the theatre where I saw them played. This was part of a small estuary in the northern half of Cardigan Bay: an arm runs out on one side at right angles to the river, thus giving during high spring tides a land-locked sheet of water nearly a mile long and half a mile wide; during neaps, even high tide failed to cover it. Numbers of Redshanks and other birds frequented this expanse, and especially its head or most landward end, where they were close to a thick bed of reeds and tussocks; the mud here was scarcely ever covered by the tide, though kept always moist by a little stream.

At one side of the head was a low ridge of grass-covered dunes, about five feet high and thirty or forty feet long, with level ground behind them. Thus, by crawling over the flat, I could get up to the dunes into an excellent position for viewing the whole top of the bay; every bird was easily seen against the wet mud. So I kept watch with the naked eye until some disturbance or unusual behaviour attracted attention; then, being armed with a telescope magnifying 30 diameters (for the loan of which I have to thank my brother, Mr. N. T. Huxley), I focussed this on the spot, and could see the minutest details of attitude and behaviour in the nearer birds, and even in those on the far side of the bay could quite well interpret what I saw. I made a number of notes on the spot, and usually within twenty-four hours embodied what I had seen the day before in a letter to an ornithological friend.

\* E. Selous, "Observations tending to throw light on the Question of Sexual Selection in Birds," etc., Part 1: *Zoologist* (4) x., 1906, pp. 201-219.

## 3. THE COURTSHIP PROPER.

I will begin with an account of the typical course of the courtship and pairing, such as I have seen repeated, with but slight variations, a considerable number of times.

Among the forty or fifty birds that usually would be quietly feeding on the flats, walking or running in short starts from mouthful to mouthful, a disturbance would every now and then be visible—two birds running, one pursuing the other. These two are cock and hen. A cock takes a fancy to one of the hens, leaves his feeding, and starts running towards her. She at once runs away from him, and there ensues a regular game of follow-my-leader. The hen never goes far in a straight line; she usually runs in a series of curves, often doubling sharply back, and sometimes describing a complete circle or even a figure of eight. Where she goes the cock goes after her, following exactly, but some yards behind. The couple would be ridiculous enough in their devious course, with heads somewhat down and quick-moving legs—rather the action of a fast-trotting horse—but the attitude of the cock adds to the effect: his eyes being set on the sides of his head, his neck has to be stretched stiff out and markedly sideways (at an angle of at least twenty degrees with the line of his body), in order to keep the hen in sight. In addition he spreads his pure white tail, so that you see half the fan of it on either side of the tips of the folded wings; but whether the hen so far ahead can see anything of this I do not know.

This pursuit goes on often for quite a long time, the birds covering maybe a quarter of a mile. The hen usually flies away, leaving the cock disconsolate, but sometimes she will consent to inaugurate the second stage of the courtship, in which she is able to inspect the suitor more closely. This she does by suddenly coming to a dead stop. The cock then perhaps runs a yard or two further, but soon he too stops, and begins his part of the second stage of the courtship.

The first stage was almost mere pursuit: the second is pure display. He first unfolds his wings and raises them right above his back, so as to expose their conspicuous under-surface of pure white somewhat clouded or barred with grey. Then, fluttering them tremulously, but keeping them raised all the time, he advances very, very slowly towards the hen, lifting his feet high in the air, and often putting them down scarcely in advance of where they were before. To the human eye the whole action seems the expression of eager excitement tempered by uncertainty, and that, presumably, is what the bird is actually feeling. Meanwhile, as he steps on, he stretches his neck a little forward, opens his mouth, and gives utterance to a single continuous note, which is changed into a long roll or rattle by the quick vibration of the lower mandible. The sound is quite like that of a Night-jar, but higher, and without any of the little breaks in the pitch of the note. So he advances closer and closer, the hen usually

remaining motionless. Again at any time during this stage she may reject his suit by flying off, but if she is going to accept him, she simply stays still, often without moving a muscle the whole time.

As the cock gets closer, he gets more and more excited, vibrates his wings more and more rapidly, at length so fast that almost his whole weight is supported by them, though he still continues to execute the high-stepping movements with his feet. At last, when just behind the hen, he abandons the ground, and flutters up on to her back, on which he half alights. The period while he is thus on her back is the third and last stage of the courtship: it is very short, and is of course in a sense nothing more than getting into the proper position for the actual pairing. But it should still be called part of the courtship, for even now the cock is not assured of his desire. Sometimes the hen, suddenly repugnant, or annoyed by the series of shriller, less continuous cries which the cock is now uttering, gives a violent jerk or sideways twist, and shakes him forcibly off on to the ground, herself running or flying away.

Occasionally, however, she apparently is satisfied; she spreads her tail diagonally, and the cock, with a quick and wonderfully graceful motion, half supported all the time by his fluttering wings, accomplishes the act of pairing. Then the hen gives the same violent twist that I have just mentioned, he gets shaken off, and they both begin quietly feeding, often side by side, but now no longer taking the least interest in each other.

That the course of true love should run so smooth was, however, quite the exception. Though I did not keep a record of the number of unsuccessful cocks that came under my observation, there must have been at the lowest estimate fifty of them, while but three times did I see the courtship consummated. Thus in something well over 90 per cent. of the cases I saw, pairing did not take place; and this was always due to the rejection of the male by the female, as the cock, once he had started a pursuit, never of his own accord abandoned it. Thus, though the hen does not actively select her mate from among a bevy of competing cocks, yet, like the modern European woman, she has the power of saying yes or no to each individual male who may choose (here literally, there metaphorically) to run after her.

The hen may reject her suitor at any time during the whole proceeding. On the one hand, I have seen her break off the courtship after a few seconds, while on the other I have seen her stop still after running, stand and watch the cock's display and gradual approach, even let him fly up on to her back, and only then with a sudden jerk throw him off and take to flight. Between these extremes there were, of course, all intermediates. During the first or pursuit stage, rejection was accomplished by the hen simply taking wing and flying off some fifty or a hundred

yards. The cock sometimes (though not usually) flew after her, settled, and began his running once more; but then she would very soon fly off again, and I never saw a cock persevere after a second such repulse. The first stage may be very short, as I have said, owing to her rejecting her suitor at once; and it may be short for the reverse reason, the hen stopping almost at once to let the cock come up for inspection. Usually, however, it is of considerable length, and in well over half the number of cases it ends in the rejection of the cock and the cutting short of the courtship before the second stage is reached.

Of the minority who survived thus far, a still larger percentage were rejected before getting to the third stage. This was most often accomplished by the hen simply flying off, leaving her suitor to fold his wings and pretend nothing had happened. Sometimes, however, if more undecided, she would behave in a curiously human way. As the cock got close she would as it were lean away from him, and at last, giving a little quiver all over, break into a short quick run of about four or five steps, like a frightened horse shying across the road. Then she stood still again, and, when the cock advanced again, very likely repeated the action. Of the five or six hens I saw act thus, all as a matter of fact at length flew off; but I have no doubt that occasionally they make up their minds in the opposite way.

#### 4. OTHER HABITS OF THE PAIRING-SEASON.

There are other habits of the pairing-season which call for special remark. I do not understand their relations to the courtship proper, and shall merely mention them here. They are introduced partly for the sake of completeness and partly to show what a number of unsolved problems still exist concerning the habits of common birds.

(a) *The Love-flight*.—This is a well-known habit. A Redshank (presumably a cock) rises up into the air and there flies in a series of switchbacks. I will quote from my own notes on a particular bird: "Just before the bottom of each switchback he gave very quick wing-flaps, almost fluttering, one would call it; this made him start up again. He went on fluttering or flapping till he was about half-way up, and for the rest of the up-stroke of the switchback he soared up with the impetus he had gained. His wings now were set back and down, his neck and head thrown up in a beautiful proud attitude, his tail spread out. Then he turned the angle of his wings and glided down, still in the same attitude." While flying thus, he gives vent to what one may well call a song—a series of pure sweet single notes, never uttered on other occasions. The flight may be quite short, or may go on and on for several minutes. It is usually, I think, gone through by single birds, but I have fairly often seen it done

by one of two or one of three birds. If so, however, it was hardly ever repeated more than a very few times. I have several times seen it take place when I have frightened a bird up from feeding.

The meaning of this habit is hard to discover, and its relation (if any) to the courtship proper is equally obscure. It is performed, I believe, only in the spring, and would certainly seem to be of the same nature as the drumming of the Snipe or the short soaring flight of the Wood-Pigeon.

(b) *The Combats of the Males*.—These have been well described by Selous (*loc. cit.*). I agree with his opinion that the combats of many birds are now at least merely formal. This was well shown in the Redshank; the birds scarcely ever touched each other, and often did not even seem fierce. It was mostly a mere running up and down of two birds facing each other, often with a very formal-looking character about it. Further observation alone can reveal its significance.

(c) *Calling from a conspicuous perch*.—This is mentioned by various writers, and is a very noticeable custom. A single bird will settle on a gate-post, railing, notice-board, or other prominent perch, and will sit there, moving its head from side to side, and uttering a single note many times repeated. Usually after every few notes there comes a short pause. Long pauses are rare. One bird continued calling thus from the same perch for 45 minutes, and was still going on when I had to stop watching. I have at present no idea as to the sex of the calling bird, or as to the purpose of the whole proceeding.

## 5. DISCUSSION.

I will confine myself in this paper to a short discussion of the courtship proper, and will begin by comparing my observations with those of Selous (*loc. cit.*); all other descriptions can here be left out of account, owing to their vague and fragmentary character.

Selous, who made his observations in Holland, seems, to start with, to have seen a greater proportion of successful courtships than I did. His description (often hard to follow, as there is no arrangement—only notes in chronological order) differs in the following chief points from mine:—

1. He seems to have seen only two examples of the first stage of the complete courtship (pp. 212, 213), which is curious, since the follow-my-leader evolutions of my birds were most conspicuous.

2. His first stage is described as follows:—"The male, approaching the female, ran about her twice or thrice, in so many half-circles, fanning his tail as he did so, and inclining his body towards her." . . . . That is to say, the hen was stationary,



instead of leading the cock a long chase, as in the Welsh birds.

3. Sometimes directly after pairing there was a curious set run or antic of the couple, *e.g.* (p. 206) :—"Two Redshanks, after pairing, run, in an excited and curious-looking manner, over the sand, following one another." Another time (p. 204), (in perhaps slightly different circumstances) :—"the birds walked, for a little, about and very near each other, fanning out their tails, whilst bending them inwards, so that, had their legs been short, they would have swept the ground at intervals, as does that of the courting pigeon."

4. He sometimes saw a male which had been definitely rejected begin courting the same female again after a short time, once or twice successfully; I never saw this happen. (This is presumably an error of omission on my part.)

These are the chief differences. His observations on the second and third stages and on the pairing itself are very similar to mine.

The differences may be ascribed either to real differences of behaviour of *Totanus calidris* in different parts of its range, or to errors or omissions of observation. Further watching alone will reveal the truth.

Further watching too must elucidate the following points, all of which ought to be known before a full discussion of the facts and of their bearing on the theory of sexual selection can take place :—

1. How often does each bird go through the act of pairing?
2. Is pairing promiscuous, or do birds pair for the season, or for life?
3. What is the relation between pairing and nest-building, and between pairing and each act of oviposition?
4. When does pairing begin in the spring, and for how long is it continued?
5. What is the relation of the love-flight, the combats, and the calling from a perch, to the courtship proper?
6. Does the female, who possesses all the structures used by the male in his display, ever use them herself for "showing off," or for any other purpose (recognition signals, etc.)?

With regard to 1, it is interesting to note that when the air was calm the Nightjar-like note described above (p. 649) could be heard at every hour of the night and day; on some nights there were one or more birds giving utterance to it practically all the time that I was listening. Now I am prepared to assert that this call is only used during the second stage of the courtship, so that the number of courtships which advanced as far as the second stage must have been very great (yet less than the number of those which never reached the second stage at all; *cf.* p. 651.)

The number of Redshanks near the head of the estuary (where alone they really congregated) was never very large. I should put fifty as an outside limit, and from observations on this and other species (*e. g.* Oyster-catchers), I believe that they are the same individual birds day after day. Therefore, even allowing that only a fraction of the courtships which reached the second stage were consummated, yet the number of acts of pairing must have been many times greater than the number of birds; probably, therefore, each bird pairs several times a day.

It is thus likely, as Selous says, that the performance of the courtship will vary very much in different circumstances; there may be satiety or eagerness in either sex, as well as timidity and shyness in the female, at different times. Selous adduces the Pheasant to prove that the display of the male may be gradually much abbreviated and scamped after the first few pairings.

As regards 4, I have very meagre evidence. I can only say that pairing had begun before the 8th of April, and was still going on very vigorously when I left Wales on the 18th. All the other questions I must leave for the present unanswered.

Selous' and my observations, however, are in themselves enough to establish one important point, namely, that the actions of the birds which lead up to each single act of pairing are explicable only on the Darwinian theory of Sexual Selection, or on some modification of that theory.

On the one hand, there is a very marked *display* by the male: the fanning of the tail in the first two stages, the lifting and fluttering of the wings, and the high-stepping with the legs in the second stage, are all obviously calculated to show off to the best advantage certain conspicuous markings which are usually concealed, while the rattling note of the second stage is to my mind equally to be considered as an excitant.

On the other hand, there is an equally marked *power of choice* shown by the female; it is perfectly clear that if a female Redshank does not want to pair with any given male, he has no possible means of forcing her to do so. He can only persuade her, or rather attempt to persuade her (by means of his display), and if she is very unfavourable to his suit, she can even prevent him from doing this, by flying off directly he begins.

Thus, though the male in this particular species has the *initiative*, the *final decision* must rest with the female.

The chief postulate of Darwinian Sexual Selection therefore holds good in the case of the Redshank:—The females have a power of choice, and the cocks have to go through a display before pairing. Moreover, the one certainly seems to stand in a causal relation to the other.

It is interesting to note, however, that although Sexual Selection is at work, yet it has not produced any appreciable difference between the sexes. This can be explained in one of three ways.

(1) The markings used in display (red legs, white tail, and whitish under surface of wings) were acquired previously by the species for some distinct purpose (*e. g.* as recognition or obliteration markings) or possibly accidentally, and then were turned to account by the cock as the "physical basis" of his display. The hen would of course possess the markings too; she differs from the male in not having secondarily acquired the instinct to display them.

(2) The markings were acquired by the cock first or primarily as secondary sexual characters, to form the basis of his display, but were either at once or later found to be of use in other ways: they would then tend to be transferred to the hen as well, either from their first beginnings, or subsequently to their definitive development in the cock, by the operation of Natural Selection.

(3) The markings were acquired for purposes of display, while in other respects they are neither harmful nor the reverse; the instinct to use them for display, however, depends on a physiological stimulus only present in the male sex. Then they would tend to be transferred to the female sex, for we generally find that the two sexes resemble each other unless there is some definite reason for their differing. It appears to be both more primitive and easier for hereditary characters to be transmitted equally to both sexes.

It is at present very hard to decide between these possibilities. Of the three, the last appears the least probable. What does emerge clearly, however, is that in considering the facts of Sexual Selection, as so often elsewhere, we must be careful not to isolate structure from function. When we speak of secondary sexual characters, we usually think of structures only. In reality the real character is the structure plus the instinct to use the structure, for it is the *use of the structure* which alone has any significance for the species: it is that which constitutes a unity, it is that which has been really acquired by the species. For purposes of convenience we separate it into two components—structure and function; but in any question of its origin and history we must always be careful to think of it as a whole. To take a concrete example: if it were proved (as is probable) that the female Redshank never used her white tail, etc. for purposes of display, we should be justified in saying that the Redshank showed secondary sexual characters—these characters being the various *actions of display* found in the male, and in the male alone.

This point of view will perhaps help to make more intelligible the various cases which have been described where the sexes are alike in plumage, but the male alone goes through a display.

35. Some Brackish-water Amphipoda from the mouths of the Weser and the Elbe, and from the Baltic \*. By E. W. SEXTON, Marine Biological Laboratory, Plymouth †.

[Received March 1, 1912: Read April 23, 1912.]

(Plates LXXIII. & LXXIV.‡)

INDEX.

	Page
Variation .....	656
Systematic: New Species under <i>Gammarus</i> .....	657

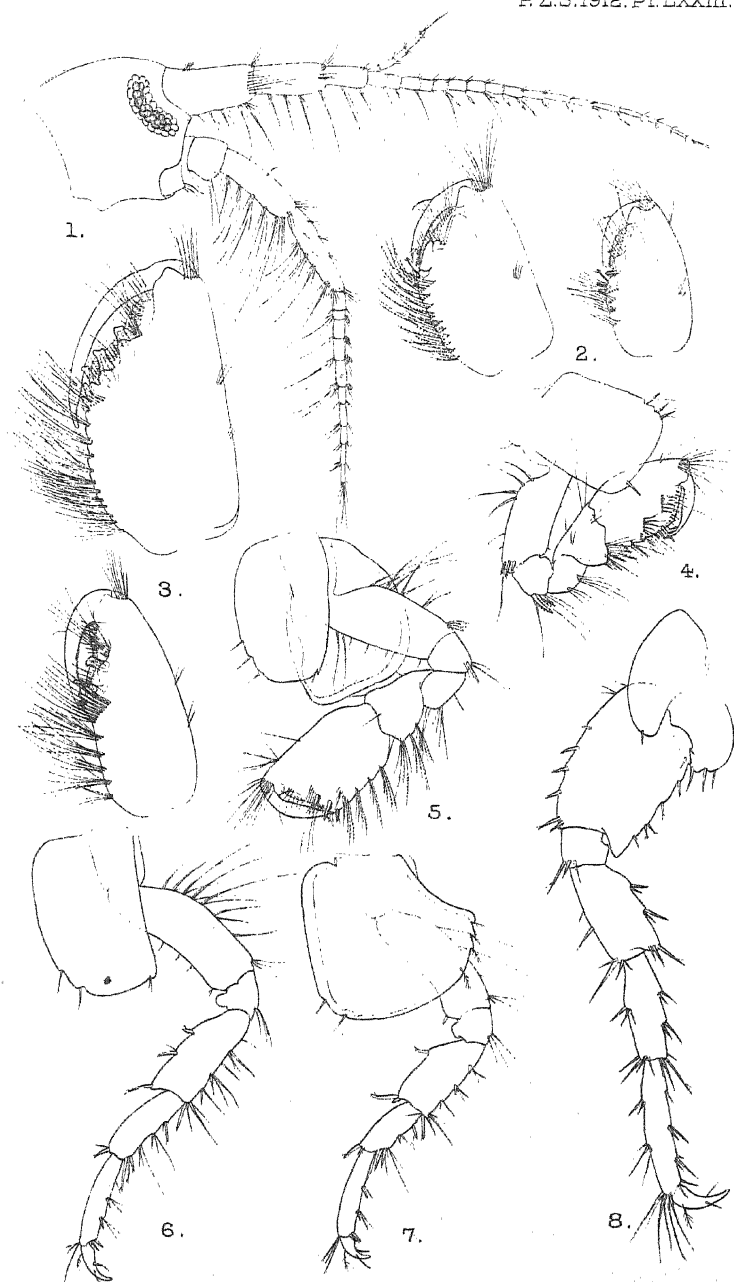
While engaged in determining the Copepoda of the harbour at Bremerhaven, Herr W. Klie met with certain Gammaridea, some of which were not easily referable to known forms. Through the intervention of a friend these were submitted to me for examination, and the present paper contains the result, with notes on some other collections of brackish-water *Gammarus*. There proved to be three species in Herr Klie's collection, one of them (*Leptocheirus pilosus* Zaddach) already known, the other two apparently new, which I described. But before the description was published I received a paper from Dr. Vanhöffen, which contained the description and figures of one of these species under the name of *Corophium lacustre*. I have therefore included here only a few notes on this species. Dr. Vanhöffen kindly allowed me to examine his specimens of Amphipoda from the Frische Haff, and it is interesting to note that the three species, *Leptocheirus pilosus* Zadd., *Corophium lacustre* Vanhöffen, and *Gammarus zaddachi*, sp. n., are present in both his and Herr Klie's collections. All three appear to flourish equally well in absolutely fresh water as in the brackish water of river estuaries and harbour basins.

The classification of the Amphipoda is rendered exceedingly difficult by the changes or modifications resulting from each successive moult. We know practically nothing yet of the factors influencing the development of any given species, except those of *growth* and *sex*. The modifications caused by these two alone are responsible for an excessive multiplication of synonyms; in some cases, *Tassa* for instance, almost every moult has been given a different specific and sometimes a different generic name by different observers. But in the species of *Gammarus*

\* [Since this paper was communicated to the Society, under the title "Some Amphipoda from Bremerhaven," the author received some large collections of the *Gammarus* described, which showed remarkable differences between those living in salt and in fresh water. These facts have been included in the text, and the title has been slightly modified.]—ED. P. Z. S.

† Communicated by the Rev. T. R. R. STEBBING, M.A., F.R.S., F.Z.S.

‡ For explanation of the Plates see p. 665.

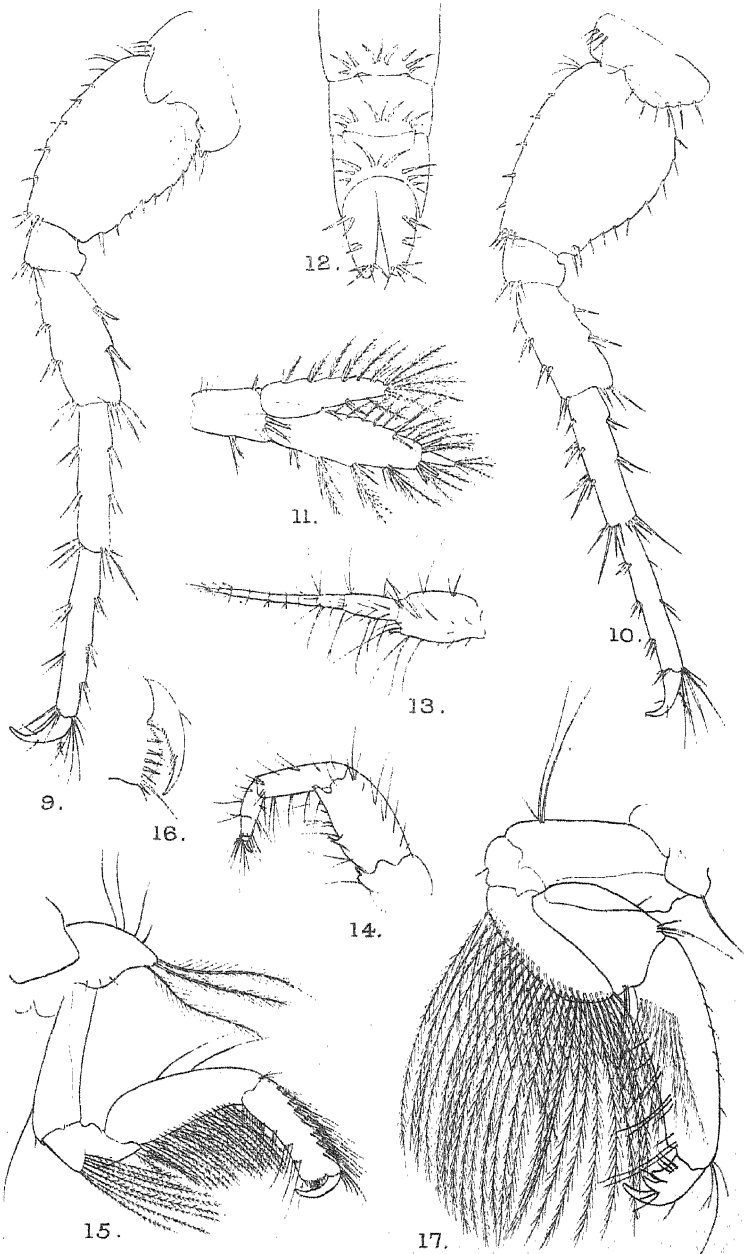


E.W. Sexton del.

Huth sc. et imp.

AMPHIPODA FROM BREMERHAVEN.





E.W. Saxon del.

Huth sc. et imp.

AMPHIPODA FROM BREMERHAVEN.





described below, certain marked modifications occur which cannot be referred to either of these influences. They would appear to be caused by the animal's environment, according as it lives in fresh water or in salt. The difference in appearance between a typical adult freshwater specimen and a typical marine or brackish-water one is so extreme as to suggest their belonging to distinct species, but structurally they are identical, and intermediate forms are very common (see below, "Moorflether Concave"), apparently varying with the degree of salinity, though on this point I cannot as yet speak definitely. Experiments have been instituted at the Laboratory here with an allied species to try and determine the question of the effect of salinity on the animal and the length of time for such effect to become evident.

GAMMARUS ZADDACHI, sp. n. (Pls. LXXIII. & LXXIV. figs. 1-12.)

=1844. *Gammarus locusta* Fabr. ?, Zaddach, Syn. Crust. Pruss. p. 4.

=1878. *Gammarus locusta* Fabr., Zaddach, Die Meeres Fauna an der preussischen Küste, pp. 26-32.

=1886. *Gammarus pulex* Kraepelin, Die Fauna der Hamburger Wasserleitung. Abhand. Geb. d. Naturw. Verein in Hamburg, Bd. ix. H. 1.

=1907. *Gammarus pulex* Volk, Mitteil. biol. Elbeuntersuchung. Naturh. Museums in Hamburg. Verhandl. Naturw. Ver. Hamburg.

=1911. *Gammarus locusta* L., Vanhöffen, Beiträge z. Kennt. d. Brackwasserfauna im Frischen Haff. Sitzung. d. Gesellsch. naturf. Freunde, Berlin, 1911, no. 9.

It is with reluctance that I have felt myself obliged to institute a new species in the already overcrowded and confused genus *Gammarus*. The species of *Gammarus* are difficult to separate except by the secondary sexual characters of the adult males; the immature of all the species are practically indistinguishable from each other, and even the females are not easy to differentiate. The species now under discussion has been frequently confounded with others, the freshwater form with *G. pulex*, and the marine and brackish-water form with *G. locusta* and *G. duebenii*; but it can be distinguished from them by a glance at the antennæ, both of which are characterised by clusters of long outstanding hairs, and by the form of the 4th sideplate and the 3rd uropod.

The brackish-water specimens are characterised by their slenderness and transparency, and the tenuity of their epidermis, while the freshwater ones are broad, very robustly built, the epidermis thick, strong and opaque, the basal joints of the hinder peræopods narrower especially in the old males, and with a much denser supply of the long fine hairs developed on the antennæ, the peræopods, particularly the hinder ones, the pleon, the 3rd

uropods, and the telson; in some cases these long hairs appear to replace the spines of the brackish-water form, *e.g.* those inset on the inferior margins of the 2nd and 3rd pleon epinera and the posterior margins of the 4th and 5th pereopods.

The finest brackish-water specimens I have seen come from the Königsberg Collection, taken at Rauschen and Zoppot, the largest freshwater ones from the Hamburg "Wasserleitung." These are larger than any of the others examined by me, probably owing to the more protected life they lead in the underground pipes, and the rich and constant supply of food.

The collections I have examined are as follows, with the names of those to whom I am greatly indebted for the opportunity of so doing:—

1. *Königsberg Museum*: Dr. Lühe. Four tubes containing Zaddach's specimens and others from Danzig Bucht, Zoppot, Koliebk, Redlan, and Rauschen, in all about 125. Most of the specimens are of the typical brackish-water form, but in one sample from Danzig in which a specimen of the freshwater *G. pulex* was also found, many of the animals were "intermediate" forms, more solidly built and with the long fine hairs developed in great numbers.

2. *Frisches Haff*: Dr. Vanhöffen. Two tubes labelled "Gammarus locusta L. Frisches Haff bei Pillau Ostpreussen. 20.ix.1911. Vanhöffen. 5." One tube contained 16 specimens, 2-5.5 mm. in length. It is interesting to note a few young *Leptocheirus pilosus* with the young *G. zaddachi*; these two species, with *Corophium volutator* and *C. lacustre*, seem to flourish equally well in fresh or brackish water and are frequently recorded together. There were 8 specimens of *G. zaddachi* in the second tube, 3.5-10 mm. long, all of the brackish-water form; the largest, however, approaching the freshwater form, strongly built and opaque.

3. *Mouth of the Oder*: Dr. Vanhöffen. One tube, "Gammarus locusta L. Dievenow Odermündung Pommern 1889. Hilgendorf. 5." 26 specimens, 1 young male *G. locusta* and 25 *G. zaddachi* exactly like those described from Pillau.

4. *Mouth of the Elbe*, from Schulan to Gauert, together with a collection from the *Hamburg Wasserleitung*; Dr. Steinhaus. This is a most interesting series taken at regular stations in the Elbe (see Volk, with map of the district), containing in all about 500 specimens. Commencing with the stations nearest the mouth of the river, where the water has nearly the full salinity of the North Sea, the details are as follows:—

"Süder-Elbe südl. Blankanese. Grund. 11.vi.00." 11 specimens 4-10 mm.

"Hafen südl. Nienstedten. Grund. 2.vi.00." 35 specimens 1.5-10 mm.

"Hafen südl. Nienstedten. 11.vi.00." 3 specimens, largest a female 11 mm.

"Linkes Elb-Ufer südl. Nienstedten. 2.ix.00." 3 specimens, largest a female 8 mm.

"Altona. Ponton. 9.vii.00." 107 specimens, all rather small, averaging 8-9 mm. in length; the eyes in these have reddish-brown pigment.

"Altona. Duc d'Alben. 1.x.00." 1 specimen, a female.

All these belong indubitably to the brackish-water type. The very young animals differ slightly from the adult, the eyes are round, the peduncles of the antennæ are about equal in length, the pleon clusters are represented each by a single spine, and the rami of the third uropod are much more unequal than in the adult. Some of the specimens, especially those from Blankanese, are more setose than the others.

"Hamburg." The "Fleet" referred to is one of the canals which run through the inner town. These canals are mostly dependent on the tide, with mud-banks exposed at low tide. "Grasbrokhafen" and "Indiahafen" are blind alleys as it were opening out of the Harbour basin; they are deep and broad, the bottom consisting of clay, sand and mud, with organic detritus deposits providing food for a rich animal life.

"Fleet 1. Grund. 25.vi.00." 1 specimen, a male 11 mm.

"Fleet 1. Krotzprobe. 23.vii.00." 1 specimen, a male, with exceptionally large eyes.

"Grasbrookhafen. Grund. 19.xi.00." 2 specimens 19-20 mm.

"Grasbrookhafen. Duc d'Alben. 20.vi.00." 18 specimens mostly small, the largest 9-10 mm.

"Indiahafen. Ponton. Oberfläche. 22.v.00." 77 specimens, all very young.

The specimens from the "Fleet" samples show intermediate characters, forming the link between the two extremes of the species. They are more solid in appearance than the brackish-water form, but the chitin is not as thick as in the freshwater animal. The spines and long hairs vary greatly in number, and the narrowing of the basal joints of the hinder peræopods also appears variable. Of the "Grasbrookhafen" specimens the two from the bottom are typical freshwater ones; the eighteen specimens from the "Duc d'Alben" (piles driven in and used for making ships fast) are all delicate in appearance, the largest showing intermediate characters. Some of the small ones, 3-4 mm. long, are extremely slender and compressed, almost thread-like, and with very few hairs. The "Indiahafen" specimens are all very small, the brackish-water form.

"Alte Dove Elbe and Moorflether Concave." Volk says of these that, taken together, they form a quiet bay with the biological characters of a backwater ("Altwasser"), but influenced to some degree by the tide. These samples are the most interesting of the series; in some both the fresh- and the brackish-water forms occur together, with the "intermediate" form.

"Moorflether Concave. Grund I. 23.vii.00." 1 specimen, a female 9 mm., with the delicate appearance of the brackish-water form, but with dense clusters of long hairs on antennæ, peræopods, and telson.

"Moorflether Concave. Oberfläche II. 23.vii.00." 11 specimens; the largest, males, measured 10–11 mm.; all the brackish-water form.

"Moorflether Concave. 23.viii.00." 129 specimens; largest 15 mm. Freshwater, brackish, and "intermediate" forms, and one specimen of the exceedingly narrow, thread-like form described from the Grasbrookhafen sample.

"Moorflether Concave. Ponton. 23.viii.00." 5 specimens, the largest, a male of 14 mm., shows the freshwater characters; the others are of the brackish-water type.

"Moorflether Concave. 24.ix.00." 37 specimens, brackish-water form, largest 12 mm.

The three following samples are all unmistakable brackish-water form. The "Prielen" are little channels cut in the banks of the river; the current is less strong, and the growth of vegetation and animal life richer than in the Elbe.

"Dove Elbe. Oberfl. 2.vii.00." 6 specimens, largest about 8 mm.

"I. P. r. O. 7.vi.00" (= Rechtsseitiger Ellbpriel am Spadenland, Oberfläche). 6 specimens, largest 10 mm.

"I. P. r. O. 2.vii.00." 14 specimens, largest 8 mm.

The remaining samples are all fine examples of the typical freshwater form.

"Kaltenhofe. 'Wasserprobe aus Filter No. 16 entnommen am 6. Dec. 1894.'" 3 specimens, the largest 22 mm.

"Hamburger Wasserleitung." 5 specimens, 18–20 mm. long.

"Hamburger Wasserleitung. Samuelson." 71 specimens. Dr. Kraepelin has given a very interesting account of the conditions of animal life in the underground "Wasserleitung" of Hamburg, conditions much more favourable than in the Elbe, owing to the greater abundance of food, the protection from many enemies, and the lesser temperature variations. He mentions this species under the name of *G. pulex* as second only in numbers to *Asellus aquaticus* among the Edriophthalma met with in the series of samples taken.

5. *Bremerhaven*: Herr Klie. One tube "Alter Hafen. x.11." 10 specimens, the largest a female 9 mm., from which several of the figures are drawn. This sample contains one of the thread-like form described above. These Bremerhaven specimens, which come from salter water than the preceding, have scarcely any of the long fine hairs developed, which so strikingly characterise the freshwater animals.

6. *Irish Lakes*: British Museum (coll. by Major Trevelyan).

"Lough Nadarragh." 4 large specimens, male and female, about 18 mm. in length. Freshwater form, exactly like those from the Hamburg Wasserleitung.

"Lough Keenaghan." 2 specimens, male and female *G. pulex*.

"Lough Keenaghan." 1 specimen, a female, freshwater form, *G. zaidachi*.

"Lough Awaddy and Tullynabour." 4 specimens, three males and one female, largest 14-15 mm. Freshwater form.

"Lough Erne." 4 specimens; two *G. zaddachi*, male and female, freshwater form; and two *G. pulex*.

The first to observe the species now under discussion was Zaddach, after whom I have accordingly named it.

In 1844 he described it under the name of "*Gammarus locusta* Fabr.?", but pointed out the characters in which it differed from Milne-Edwards's description, adding that if the latter were correct, his (Zaddach's) species must be regarded as new. In his later work he gives a more detailed description and figures of the species, again, however, emphasizing the differences in the antennæ and the 3rd uropods. Zaddach's specimens are still preserved at Königsberg Museum. The *G. locusta*, described by Chevreux (Bull. Soc. Zool. v. xvii. p. 141) as inhabiting the Loire and the mouths of rivers of Corsica and Provence, is very probably the species here described.

The principal points of difference between this newly-established species and *G. locusta* lie in the antennæ, in the proportions of the peduncle-joints of antenna 1, and in the setæ, in the gnathopoda, in the 4th side-plate, in the armature of the pleon, and in the 3rd uropod.

It differs from *G. duebenii*, specimens of which were kindly sent to me by Professor Sars for comparison, in the following points:—The upper antenna of *G. duebenii* is only sparsely furnished with hairs, and has none of the regular graduated clusters so characteristic of *G. zaddachi*; the hands of gnaths. 1 and 2 are smaller, and practically subequal in size, in *G. zaddachi* the hand of gnath. 2 is decidedly larger than that of gnath. 1; in the adult *G. duebenii* the basal joints of pereopods 3, 4, and 5 are all expanded, with the hind corners free, while in *G. zaddachi* these joints are hardly expanded at all in the male, and only the 3rd has the hind corner free; in the largest *G. duebenii* the 1st and 2nd uropods and the telson reach to the level of the peduncle of uropod 3, and the outer ramus of urop. 3 is twice the length of the outer ramus of urop. 1 (in the smaller specimens the proportions are as figured by Sars, Crust. Norway, vol. i. pl. 177); in *G. zaddachi* urop. 1 is considerably longer than urop. 2, and the outer ramus of urop. 3 only half as long again as that of urop. 1; the telson in *G. duebenii* is shorter, broader, and more spinose.

From *G. pulex* it is distinguished at once by the shape of the eye, small and rounded in *G. pulex*, large and reniform in *G. zaddachi*; the antennæ, gnathopods, 4th sideplate, pleon armature, and the 3rd uropods also differ.

The Bremerhaven and Frisches Haff specimens are all young, the largest, a female figured on Pl. LXXIII., measuring 9 mm. The largest male in the Königsberg collection measures 18.5 mm.; the females are much smaller and broader, 12-13 mm., but none

of them are ovigerous. The largest Hamburg specimen measures 22 mm.

The *body* is slender and compressed, the brackish-water specimens much more delicate in appearance than the freshwater ones.

*Head* (fig. 1) about equal in length to the first two pereon-segments, in *G. locusta* it is distinctly shorter; lateral lobes obliquely truncate, upper angle usually subacute in large specimens, and obtusely rounded in smaller ones, rounded below, sinus small.

*Side-plates* smaller than in *G. locusta*, about as deep as the corresponding segments, 1-4 serrated at the anterior angle. The 4th, which forms one of the distinguishing characters of the species, is as broad as deep, with the posterior expansion short and rounding into the inferior margin. In *G. locusta* the posterior expansion is very deep, with the hind margin straight and much more serrated.

*Pleon-segments* 1-3 with the postero-lateral corners acutely produced, with only two or three setules inset on the hind margin. Segments 4-6 each with three groups of spines. The number of spines is very variable: generally speaking, the median group has two spines, and the lateral groups three each set fan-wise, and accompanied as a rule by long fine hairs, more numerous in the freshwater animals; but many of the larger animals have three spines in the median group of the 4th segment, and two in the 5th and 6th, and four spines in the lateral groups of the 4th and 5th segments, and three in those of the 6th. The number varies, however, even in animals of the same size. The spines are longer than in *G. locusta*, and inset at a rather different level; the dorsal groups are only slightly raised, whereas in *G. locusta* they are elevated and prominent.

*Eyes* large, reniform, very dark; outer row of ommatidia colourless.

*Antenna* 1 not quite half as long as the body, much more setose in the male than in the female. The peduncle is longer than in any other known species of *Gammarus*, nearly equalling the peduncle of ant. 2 in length in the adult, and quite equal to it in the young animal. It is furnished inferiorly with the outstanding clusters of stiff setæ characteristic of the species, some of the setæ in each cluster extending far beyond the rest, and graduating in length to the distal end of each joint. The 1st joint is longer than the 2nd, but not as long as the 2nd and 3rd taken together. The primary flagellum is 18-jointed in the largest Bremerhaven specimen, with 5 joints in the accessory flagellum; the largest male from Rauschen had 33 joints in the primary, and 8 in the accessory, the smaller animals averaged 23-27 in the one, and 4-6 in the other. Zaddach gives the range as from 25-35 in the primary, and 5-9 in the accessory. Each joint in the primary flagellum from about the 5th carries a small stalked sensory filament in addition to the small setæ, and a long seta on alternate joints. In *G. locusta* the

peduncle is noticeably shorter than that of ant. 2, extending only to the distal end of the 4th joint of the latter, instead of to half the length of the 5th, as in our species; both the peduncle and flagella are very sparsely provided with setæ, and the accessory flagellum is much longer, 13-14-jointed in the male, with about 47 joints in the primary.

*Antenna* 2 shorter; 4th joint of the peduncle slightly shorter than the 5th, both furnished inferiorly with the characteristic clusters of setæ. The flagellum is about as long as the 4th and 5th joints of the peduncle combined, 11-jointed in the largest Bremerhaven specimen, 15-19-jointed in the large males from Rauschen; in both sexes calceolæ occur on the proximal joints and clusters of setæ similar to those of the peduncle.

In the male of *G. locusta*, and to a less degree in the female also, both the peduncle and flagellum are clothed with dense tufts of long fine delicate setæ. The almost glabrous first antenna and the exceedingly hairy second antenna of *G. locusta* are sufficient to distinguish the species from *G. zadlachi* at a glance.

*Gnathopoda*.—The difference between the gnathopods of the males of the two species will be better seen by referring to Pl. LXXIII. figs. 2-5. In *G. zadlachi* (fig. 2) they are much broader in proportion to their length, with the palm less oblique and the palmar margin crenulate. In *G. locusta* (fig. 3) the palmar margin is sinuous, the clusters of setæ on the hind margin are much denser, the setæ, as in ant. 2, are very fine and long, and the palmar spines are of different structure.

In the female (figs. 4 & 5) the second gnathopod only carries a spine midway on the palm; the finger is much more pointed than in the male.

*Pereopoda*.—The proportions differ from *G. locusta*, the 4th joint being much shorter in proportion and broader, and the 6th joint, except in pereopod 1, always exceeds it in length. The 2nd joint in pereopod 3 has the lower hind corner produced, subacute; this joint in pereopods 4 and 5 is narrowed distally, the hind corners not free, but with one or two strong spines inset at the angle (see fig. 10). In most of the large males the basal joints are long, very narrow, and scarcely at all expanded posteriorly; in the female and immature specimens they are always shorter and more expanded than in the adult male. Generally speaking the posterior margins of the basal joints and the inferior margins of the 2nd and 3rd pleon segments are beset with small spines in the brackish-water form, and with long setiform spines or setæ in the freshwater form, but this again is not an invariable rule, some specimens having spines on the hinder pereopods and setæ on the pleon epimera or *vice versa*. The hinder pereopods in the freshwater animals are covered with long fine hairs set in clusters with the spines; these hairs are not much developed in the animals from salt water, but, on the other hand, they are provided with more spines.

The *uropoda* are more slender than in *G. locusta*. In uropod 3

(fig. 11) the inner ramus is about three-quarters the length of the 1st joint of the outer ramus; in *G. locusta* it reaches to the distal end of the 1st joint, and both rami are more richly furnished with spines and plumose setæ.

*COROPHIUM LACUSTRE* Vanhöffen, 1911. (Pl. LXXIV. figs. 13-17.)

1911. Beitr. z. Kennt. d. Brackwasserfauna im Frischen Haff.

The largest male measured 3.5 mm.; the largest female 5.5 mm.

*Body* broad, hardly at all compressed. Side-plate 1 with three very long plumose setæ at the anterior angle.

*Pleon-segments* 4-6 coalesced, strongly resembling *C. acutum* Chev.

*Head.* The rostrum in the male is much produced, apex sub-acute; not so prominent in the female, apex obtuse. Lateral lobes rounded, produced, but not to the level of the rostrum.

*Eyes* large for the genus, irregularly round, pigment black.

*Antenna* 1.—The peduncle in the male is clothed with long hairs; 1st joint nearly as long as the 2nd and 3rd combined; in the female (Pl. LXXIV. fig. 13) the first joint is longer than the 2nd and 3rd taken together; in both, it is produced below apically and tipped with one short stout spine; 3rd joint much shorter than the 2nd. The flagellum is shorter than the peduncle, about 9-jointed in the male and 7-jointed in the female; terminal joint rudimentary, the last three joints each carry a cluster of sensory filaments.

*Antenna* 2 very stout; in the male the large 4th joint of the peduncle carries two apical teeth, the outer one much the larger, recurved. The 5th joint and the flagellum are furnished inferiorly with clusters of very long fine hairs. The flagellum consists of two joints, the small terminal one with two strong spines. In the female (fig. 14) the 3rd joint of the peduncle is produced apically into a small process tipped with a spine; the 4th joint has a similar process midway on the inferior margin, and a long apical tooth with a spine inset at the tip; 5th joint almost as long as the 4th. The flagellum as in the male, but showing one joint-division more; one spine on the terminal joint.

*Gnathopod* 1 (figs. 15 & 16).—5th joint longer than the 6th, tapering distally; 6th as wide at the palm as at the base, but with hind margin lightly curved; front margin with transverse rows of setæ; the palm convex, serrulate, fringed with six small spines; the finger curved, acute, inner margin serrulate, with three or four setules inset subapically.

*Gnathopod* 2 (fig. 17) much as in *C. triaenonyx* Stebbing. The 2nd joint is expanded, more so in the male than in the female; 6th joint long, tapering distally. The finger is tridentate; teeth upturned, the 3rd the largest, with small stiff setæ inset between.



*Pereopods* 1 and 2 stoutly built; the posterior margin of the 2nd joint and both margins of the 4th are fringed with long fine setæ in the male, but carry only a few setæ at intervals in the female. The finger has the glandular aperture opening at the tip.

The *hinder pereopods* are alike in both sexes. The 5th is long and slender, about twice the length of the 3rd. The fingers of pereopods 3 and 4 are strongly recurved, that of pereopod 5 falciform. The posterior margin of the 3rd is furnished with a few simple setæ, that of the 4th with plumose setæ, while both margins of the 5th are densely fringed with long and short plumose setæ; the 6th joint of this pereopod carries two or three clusters of remarkably long setæ posteriorly.

The incubatory lamellæ are long, narrow, and fringed with very long hairs, that of pereopod 3 almost equals the pereopod in length.

*Telson* the same in both sexes, about twice as broad as long, the apex obtusely truncate; a pair of mobile setæ inset on each side near the base.

## EXPLANATION OF THE PLATES.

## PLATE LXXIII.

- Fig. 1. Head of *Gammarus zaddachi*, sp. n., young female, 9 mm. Bremerhaven. The clusters of hairs are much denser in the males and in the older females.  $\times 42$ .
2. Hands of gnathopods 1 and 2, *G. zaddachi*, large male, 17 mm. Rauschen.  $\times 20$ .
3. Hands of " " *G. locusta*, large male, 17 mm. Plymouth Sound.  $\times 20$ .
4. Gnathopod 1. Young female. Bremerhaven. *G. zaddachi*.  $\times 42$ .
5. " 2. " " " "  $\times 42$ .
6. Pereopod 1. " " " "  $\times 42$ .
7. " 2. " " " "  $\times 42$ .
8. " 3. " " " "  $\times 42$ .

## PLATE LXXIV.

- Fig. 9. Pereopod 4. Young female, 9 mm. Bremerhaven. *G. zaddachi*, sp. n.  $\times 42$ .
10. " 5. " " " " "  $\times 42$ .
11. Uropod 3. " " " " "  $\times 42$ .
12. Diagrammatic dorsal view of pleon segments 4-6 and telson, showing the arrangement of the spine clusters; in the males and older females, particularly in the freshwater form, these clusters are always accompanied by long fine hairs. Young female, 9 mm.  $\times 42$ .
13. Antenna 1. Female. *Corophium lacustre* Vanhöffen. Bremerhaven.  $\times 42$ .
14. " 2. " " " " "  $\times 42$ .
15. Gnathopod 1. Male. " " " " "  $\times 58$ .
16. Finger and palm, gnathopod 1. Male. *Corophium lacustre* Vanhöffen. Bremerhaven.  $\times 145$ .
17. Gnathopod 2. Male. *Corophium lacustre* Vanhöffen. Bremerhaven.  $\times 58$ .

36. Descriptions of new Fishes of the Family Loricariidae in the British Museum Collection. By C. TATE REGAN, M.A., F.Z.S.

[Received March 5, 1912; Read April 23, 1912.]

(Plates LXXV.-LXXVII.\*)

Systematic:	INDEX.	Page
<i>Plecostomus hondæ</i> , sp. n.....		666
<i>Chatostomus palmeri</i> , sp. n.....		667
<i>C. lepturus</i> , sp. n. ....		667
<i>C. paucispinis</i> , sp. n. ....		667
<i>Xenocara heterorhynchus</i> , sp. n.....		668
<i>X. multispinis</i> , sp. n. ....		668
<i>Otocinclus maculipinnis</i> , sp. n. ....		668
<i>Oryloricaria tamanae</i> , sp. n. ....		669
<i>O. leightoni</i> , sp. n. ....		669
<i>Arges cirratus</i> , sp. n.....		670

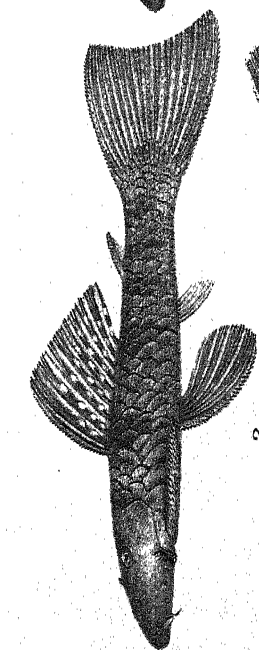
During the last three years several Loricariid fishes have been added to the British Museum Collection, including examples of the following ten species new to science.

1. *PLECOSTOMUS HONDÆ*, sp. n. (Pl. LXXVI. fig. 3.)

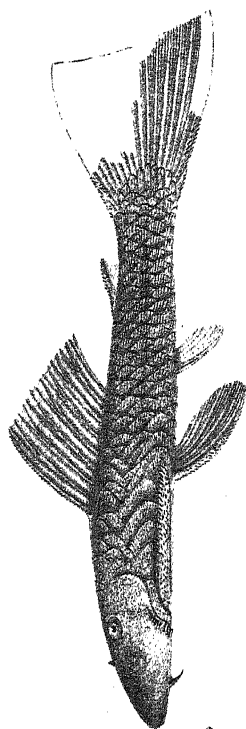
Depth of body  $4\frac{2}{3}$  in the length, length of head 3. Depth of head  $1\frac{3}{4}$  in its length, breadth  $1\frac{1}{4}$ , snout  $1\frac{3}{4}$ , eye 7, interorbital width  $2\frac{1}{5}$ . Length of mandibular ramus 3 in interorbital width; jaws with about 12 teeth on each side. Snout ovate; supra-orbital margins slightly raised; supraoccipital convex, without distinct ridge; temporal plates not or but feebly keeled. Scutes spinulose, weakly carinate, 27 or 28 in a longitudinal series, 7 between dorsal and adipose fin, 13 between anal and caudal; supraoccipital entirely bordered posteriorly by a single scute; lower surface of head and abdomen with a few scattered granules (probably covered with granular scales in the adult). Dorsal 17; first ray nearly as long as head, last  $\frac{2}{3}$  as long; base more than distance from tip of spine of adipose fin. Anal 14. Pectoral spine extending to anterior  $\frac{1}{4}$  of ventrals. Caudal emarginate, the middle rays  $\frac{1}{2}$  as long as the outer ones, which are longer than the head. Caudal peduncle 3 times as long as deep. Reddish brown, with traces of darker spots on head and anterior part of body; dorsal red, with three series of dark spots between the rays; caudal with alternate red and dusky bars; lower fins reddish, with dark spots.

Two specimens, 80 mm. in total length, from Honda, Colombia (300-400 ft.), presented in 1909 by Sir Bryan Leighton.

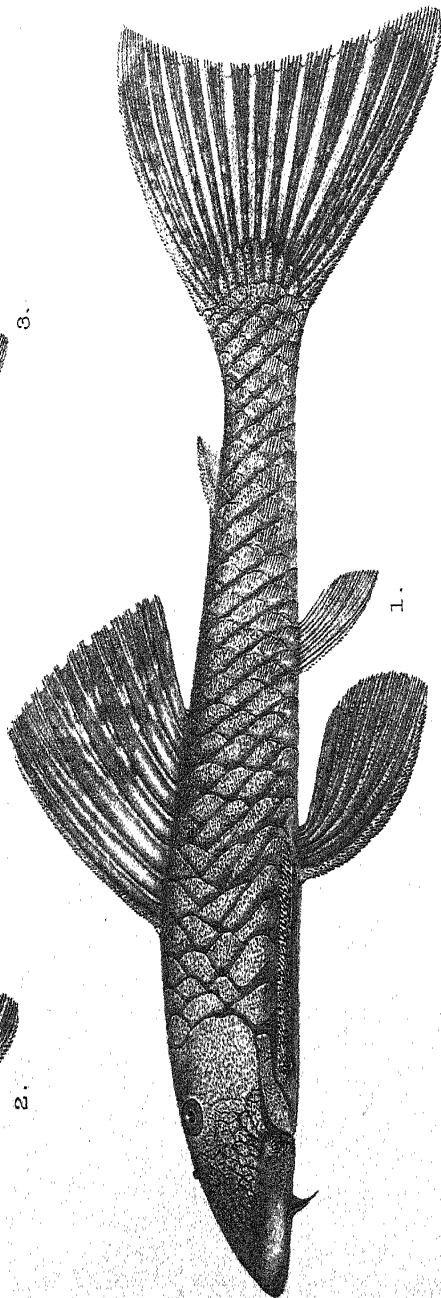
\* For explanation of the Plates see p. 670.



1.



2.



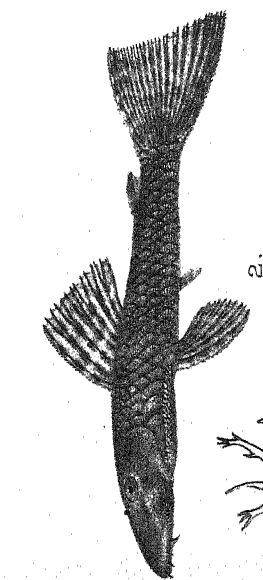
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A. H. Searle, del et lith.

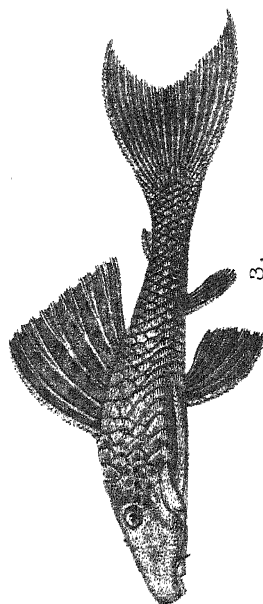
Hutch, imp.

1. CHAETOSTOMUS LEPTURUS. 2. C. PAUCISPINIS. 3. C. PALMERI.

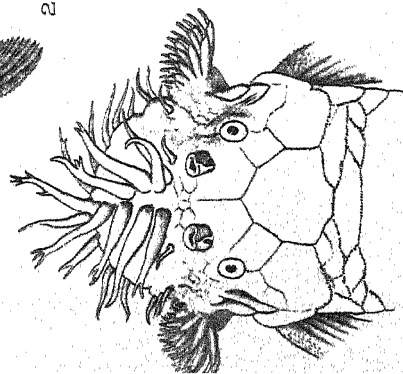




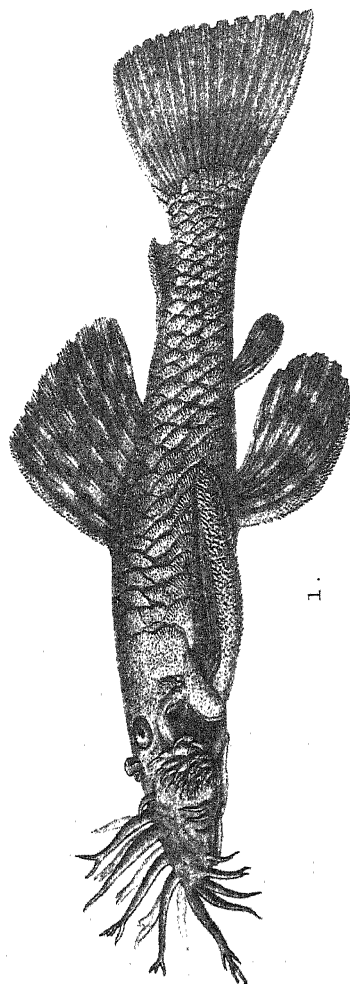
2.



3.



1 a.



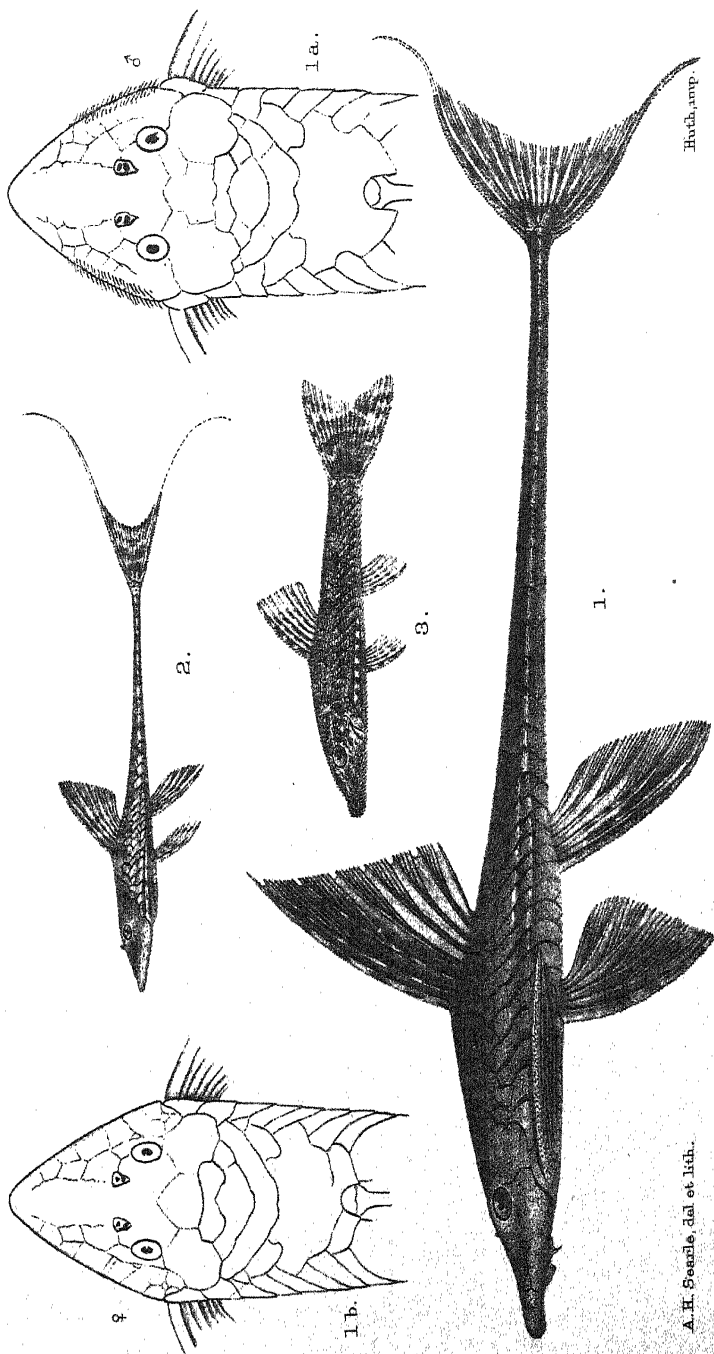
1.

A.H. Seale del et lith.

Hutch, imp.

1. XENOCARA MULTISPINIS. 2. X. HETERORHYNCHUS. 3. PLECOSTOMUS HONDAE.





A. H. Searle, del et lith.

H. H. Searle, amp.

1. OXYLOPHYCARIA TAMANAE, (x 7/8) 2. O. LEIGHTONI. 3. OTOCINCLUS MACULIPINNIS, (x 2)





2. *CHÆTOSTOMUS PALMERI*, sp. n. (Pl. LXXV. fig. 3.)

Nearest to *C. fischeri* Steind. Depth of body  $5\frac{1}{2}$  in the length, length of head  $3\frac{1}{4}$ . Head a little longer than broad and nearly twice as long as deep. Diameter of eye  $6\frac{1}{2}$  to 8 in length of head, interorbital width 3 to  $3\frac{1}{3}$ , length of snout  $1\frac{2}{3}$  to  $1\frac{3}{4}$ . Length of mandibular ramus equal to interorbital width. Interoperculum with 2 or 3 spines. 24 scutes in a longitudinal series, 6 or 7 between dorsal and adipose fin, 11 between anal and caudal. Dorsal I 8; first ray  $\frac{2}{3}$  to  $\frac{3}{4}$  the length of head, last  $\frac{1}{2}$  as long; length of base equal to distance from posterior part of spine of adipose fin. Anal I 5. Pectoral spine just reaching base of ventral. Caudal peduncle  $2\frac{1}{2}$  times as long as deep. Coloration uniform; dorsal and caudal with or without series of spots on the rays.

Two specimens, 75 and 95 mm. in total length, from the Rio Tamana, Rio San Juan, Choco, S.W. Colombia, collected by Mr. G. Palmer.

3. *CHÆTOSTOMUS LEPTURUS*, sp. n. (Pl. LXXV. fig. 1.)

Depth of body  $5\frac{1}{2}$  to 6 in the length, length of head  $3\frac{1}{2}$  to  $3\frac{3}{4}$ . Head nearly as broad as long and almost twice as long as deep. Diameter of eye 8 to  $9\frac{1}{2}$  in length of head, interorbital width  $3\frac{1}{5}$  to  $3\frac{1}{3}$ , length of snout  $1\frac{3}{5}$  to  $1\frac{2}{3}$ . Length of mandibular ramus equal to interorbital width. Interoperculum with 5 to 8 spines. 25 scutes in a longitudinal series, 6 or 7 between dorsal and adipose fin, 11 or 12 between anal and caudal. Dorsal I 8; first ray nearly as long as head, last  $\frac{2}{5}$  to  $\frac{1}{2}$  as long; length of base equal to or slightly more than its distance from adipose fin. Anal I 5. Caudal obliquely emarginate. Caudal peduncle  $3\frac{1}{2}$  to 4 times as long as deep. Coloration as in *C. marginatus* Regan, from which this species differs especially in the form of the dorsal fin and the more slender tail.

Three specimens, 135 to 215 mm. in total length, from the Rio Tamana, Rio San Juan, Choco, S.W. Colombia, collected by Mr. G. Palmer.

4. *CHÆTOSTOMUS PAUCISPINIS*, sp. n. (Pl. LXXV. fig. 2.)

Depth of body 5 in the length, length of head  $3\frac{1}{5}$ . Head as broad as long and  $1\frac{1}{5}$  as long as deep. Diameter of eye 8 in length of head, interorbital width 3, length of snout  $1\frac{3}{4}$ . Interoperculum with 2 spines. 24 scutes in a longitudinal series, 6 between dorsal and adipose fin, 10 between anal and caudal. Dorsal I 9; first ray a little less than  $\frac{3}{4}$  length of head, last  $\frac{2}{5}$  as long; length of base equal to distance from tip of spine of adipose fin. Anal I 5. Pectoral spine extending to base of ventral. Caudal very slightly emarginate. Caudal peduncle  $2\frac{1}{4}$  times as long as deep. Back with dark cross-bars; dorsal fin with series of spots on the rays; tips of all the fins reddish.

A single specimen, 90 mm. in total length, from Tado, Rio San Juan, Choco, Colombia, collected by Mr. G. Palmer.

5. *XENOCARA HETERORHYNCHUS*, sp. n. (Pl. LXXVI. fig. 2.)

Depth of body 6 to  $6\frac{1}{2}$  in the length, length of head  $2\frac{3}{5}$  to  $2\frac{3}{4}$ . Head longer than broad and more than twice as long as deep. Diameter of eye 7 or 8 in length of head, length of snout  $1\frac{3}{4}$  to 2, interorbital width 3. Length of mandibular ramus  $1\frac{1}{5}$  to  $1\frac{1}{3}$  in interorbital width. Snout with tentacles. Interoperculum with about 10 spines, the longest about  $\frac{1}{5}$  the length of head. 23 or 24 scutes in a longitudinal series, 7 or 8 between dorsal and adipose fin, 11 or 12 between anal and caudal. Dorsal I 7; first ray  $\frac{1}{2}$  to  $\frac{2}{5}$  the length of head, last, when laid back, separated by 3 keeled scutes from adipose fin; base of dorsal equal to or less than its distance from adipose fin. Anal I 3. Pectoral spine extending to base of ventral. Caudal obliquely truncate. Caudal peduncle 3 times as long as deep. Fins with series of dark spots.

Two specimens (♀), 58 and 80 mm. in total length, from Uruhuasi, Peru (4000 ft.), collected by Messrs. H. & C. Watkins.

This species is related to *X. bufonium*, differing somewhat in proportions and also in the much greater width of the naked margin of the snout, into which the bony plates extend as a narrow median prominence nearly reaching the apex of the snout.

6. *XENOCARA MULTISPINIS*, sp. n. (Pl. LXXVI. fig. 1.)

Depth of body about 5 in the length, length of head  $2\frac{1}{4}$ . Head longer than broad and twice as long as deep. Diameter of eye 8 to  $9\frac{1}{2}$  in length of head, interorbital width  $2\frac{3}{5}$  to  $2\frac{1}{2}$ , length of snout  $1\frac{1}{2}$  to 2. Length of mandibular ramus 2 in the interorbital width. Snout with many long tentacles (♂). Interoperculum with 20 to 25 spines, the longest  $\frac{1}{4}$  the length of head. 24 scutes in a longitudinal series, 6 or 7 between dorsal and adipose fin, 10 or 11 between anal and caudal. Dorsal I 7; first ray about  $\frac{2}{5}$  length of head, last about  $\frac{2}{3}$  as long; base equal to distance from posterior part of spine of adipose fin. Anal I 4. Pectoral spine extending to anterior  $\frac{1}{2}$  or middle of ventral. Caudal obliquely truncate. Caudal peduncle  $2\frac{1}{2}$  to  $2\frac{2}{3}$  times as long as deep. Traces of rather large pale spots on head; dorsal and lower fins with series of dark spots; caudal dusky.

Three specimens (♂), 90 to 120 mm. in total length, from the Humboldt and Novo Rivers, Sta. Catherina, S.E. Brazil, collected by Mr. W. Ehrhardt.

This species is near to *X. stigmaticum* Eigenm., and except for the larger size of the spots on the head might as justly be referred to that species as those that I described as *X. stigmaticum* from the Mogy-guassu River. Dr. R. von Ihering has written to me that this locality is not 250, but only 25 miles inland of Santos.

7. *OTOCINCLUS MACULIPINNIS*, sp. n. (Pl. LXXVII. fig. 3.)

Closely related to *O. nigricauda* and *O. perforatus*. Depth of body about  $5\frac{1}{2}$  in the length, length of head  $2\frac{3}{4}$ . Diameter of eye

about 7 in length of head, interorbital width  $2\frac{2}{3}$ , length of snout 2 to  $2\frac{1}{5}$ . Occipital region evenly convex, without crests. Scutes spinulose, not carinate, 22 to 24 in a longitudinal series. Lower surface of head with a naked area in front of clavicles; abdomen with 4 or 5 irregular series of plates between the lateral series. Dorsal I 7; origin a little behind base of pelvics, but not much nearer to end of snout than to base of caudal. Anal I 5. Pectoral spine extending beyond middle of ventral. Caudal emarginate. Caudal peduncle 3 times as long as deep. Fins with series of dark spots.

Four specimens, 30 to 35 mm. in total length, from the La Plata, presented in 1909 by Herr J. Paul Arnold.

8. *OXYLORICARIA TAMANÆ*, sp. n. (Pl. LXXVII. figs. 1, 1a, 1b.)

Head  $5\frac{1}{4}$  in the length. Breadth of head  $1\frac{1}{4}$  (♂) or  $1\frac{1}{3}$  (♀) in its length, diameter of eye 7 to 8, interorbital width  $3\frac{1}{3}$ , length of snout  $1\frac{5}{7}$ . Snout without distinct rostrum; supraorbital edges not or scarcely raised; sides of the snout, in the male, with bristles. 32 or 33 scutes in a longitudinal series (14-15+18); lateral keels weak, obsolete anteriorly, united posteriorly. A naked area surrounding the lips; abdomen posteriorly with 3 series of plates between the lateral series; an anal plate bordered anteriorly by 3, these 3 again by 5. Dorsal elevated, its height  $\frac{1}{4}$  the length of the fish; pectoral spine extending to anterior  $\frac{1}{3}$  of ventral; caudal emarginate, the outer rays produced. Breadth of body at level of last anal ray  $4\frac{1}{2}$  to 5 in the distance from the caudal. Anterior half of dorsal blackish; caudal blackish at the base; pectoral blackish, pelvics more or less dusky, anal spotted anteriorly.

Two examples (♂, ♀), 225 and 200 mm. in total length, from the Rio Tamana, Rio San Juan, Choco, S.W. Colombia (200 ft.), collected by Mr. G. Palmer.

9. *OXYLORICARIA LEIGHTONI*, sp. n. (Pl. LXXVII. fig. 2.)

Head  $4\frac{1}{2}$  in the length. Breadth of head  $1\frac{2}{5}$  to  $1\frac{1}{2}$  in its length, diameter of eye 8, interorbital width  $3\frac{1}{3}$  to  $3\frac{1}{2}$ , length of snout  $1\frac{1}{3}$  to 2. Snout without distinct rostrum; supraorbital edges not or scarcely raised. 30 scutes in a longitudinal series (15+15); lateral keels weak, united posteriorly. A naked area surrounding the lips; abdominal plates posteriorly forming 3 or 4, anteriorly 6 or 7, irregular series between the lateral series; an anal plate bordered anteriorly by 3. Height of dorsal equal to length of head; pectoral spine extending to anterior  $\frac{1}{4}$  of ventral; caudal emarginate, the outer rays produced. Breadth of body at level of last anal ray  $\frac{1}{5}$  the distance from caudal. Fins with blackish spots; anterior part of dorsal blackish at base and near tip.

Two specimens, 55 and 65 mm. in total length, from Honda, Colombia (300-400 ft.), presented in 1909 by Sir Bryan Leighton.

## 10. ARGES CIRRATUS, sp. n.

Length of head  $3\frac{2}{3}$  in the length of the fish. Interocular width rather more than distance from eye to posterior nostril, rather less than  $\frac{1}{2}$  the length of head. Nasal flap produced into a barbel which is as long as the diameter of the eye; maxillary barbel not quite reaching gill-opening; teeth of outer series of premaxillaries unicuspid, acute; mandibular teeth bicuspid. First dorsal ray  $\frac{2}{3}$  the length of head; pectoral extending to base of ventral; ventrals inserted below anterior part of dorsal, nearly reaching anal. Spine of adipose fin well developed, movable, connected by a membrane with the caudal peduncle, inserted at a distance from caudal equal to about  $\frac{1}{3}$  the length of the middle rays of that fin. Distance from tip of snout to origin of dorsal fin  $2\frac{3}{5}$  in the length of the fish, from base of last anal ray to caudal  $5\frac{2}{3}$ . A few large dark spots on body; a blackish bar across middle of caudal fin.

A single specimen, 24 mm. in total length, from the Rio Condoto, Rio San Juan, S.W. Colombia, collected by Mr. G. Palmer.

## EXPLANATION OF THE PLATES.

## PLATE LXXV.

- Fig. 1. *Chatostomus lepturus*.  
 Fig. 2.       "       *paucispinis*.  
 Fig. 3.       "       *palmeri*.

## PLATE LXXVI.

- Fig. 1. *Xenocara multispinis*.  
 Fig. 2.       "       *heterorhynchus*.  
 Fig. 3. *Plecostomus honda*.

## PLATE LXXVII.

- Fig. 1. *Oryzias latipes* ( $\times \frac{7}{8}$ ).  
 Figs. 1 a, 1 b. Heads of ♂ & ♀.  
 Fig. 2. *O. leightoni*.  
 Fig. 3. *Otocinclus maculipinnis* ( $\times 2$ ).
-

## EXHIBITIONS AND NOTICES.

April 23, 1912.

Dr. S. F. HARMER, F.R.S., Vice-President,  
in the Chair.

The SECRETARY exhibited a living specimen of a young female Dorsal Hyrax (*Dendrohyrax dorsalis*) from Nigeria, recently presented to the Society by Mr. J. L. McKellar.

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The SECRETARY exhibited a number of photographs of an Elephant Kraal in Siam which had been presented to the Society by the Rt. Hon. Sir Cecil Clementi Smith, P.C., G.C.M.G.

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May 7, 1912.

Prof. E. A. MINCHIN, F.R.S., Vice-President,  
in the Chair.

Mr. R. I. Pocock, F.R.S., F.L.S., F.Z.S., Superintendent of the Gardens, exhibited a skin and a living specimen of a fawn variety of the Brown Rat (*Epimys norvegicus*), which had been caught on an island in the middle of Loch Corrib, Co. Galway, and presented to the Society by Lord Headley. Mr. Pocock remarked that although similarly coloured varieties of this rat had been caught now and again in different parts of England, it was especially interesting to put on record Lord Headley's statement that it was quite common on the island, no fewer than eleven having been trapped while others had been seen; and that it did not occur, so far as was known, on the mainland. Typically coloured brown rats lived on the island as well.

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Mr. D. SETH-SMITH, Curator of Birds, exhibited two horn-like sheaths which had been shed from the orange-coloured patch at the base of the lower mandible of the King Penguin (*Aptenodytes pennanti*) living in the Society's Gardens. Mr. W. E. de Winton had observed the shedding of this epidermal sheath in a bird living in the Gardens in 1898 (P. Z. S. 1898, p. 900); but although the present specimen had been carefully watched during two successive moults in March and October 1911 (P. Z. S. 1912, p. 60), no sign of this process was observed. The bird, however, went through another complete moult in March to April of the present year (1912), and shortly after this was completed the epidermal covering of the orange-coloured patches became loose and finally

fell off; the pieces somewhat resembled the wing-cases of a large beetle, being semi-transparent and of a clear orange-colour.

Dr. FRANCIS WARD, F.Z.S., showed a number of photographs and diagrams illustrating a method of observation of fishes, birds, and mammals under the water, the principle being that the subjects under consideration were illuminated by natural light, and the observer, being in a dark chamber in the water, was not seen. The appearance of black-feathered birds was shown; these, by carrying down air-bubbles among the feathers, were converted into reflectors: and a Water-Hen was shown bright red and then green as it reflected the different surroundings in which it had been placed. Otters and Seals were also shown as seen under the water. The demonstration was illustrated by numerous slides and by the cinematograph.

## PAPERS.

37. On a Collection of Fishes made by Mr. A. Blayney Percival in British East Africa to the East of Lake Baringo. By G. A. BOULENGER, F.R.S., F.Z.S.\*

[Received April 2, 1912: Read May 7, 1912.]

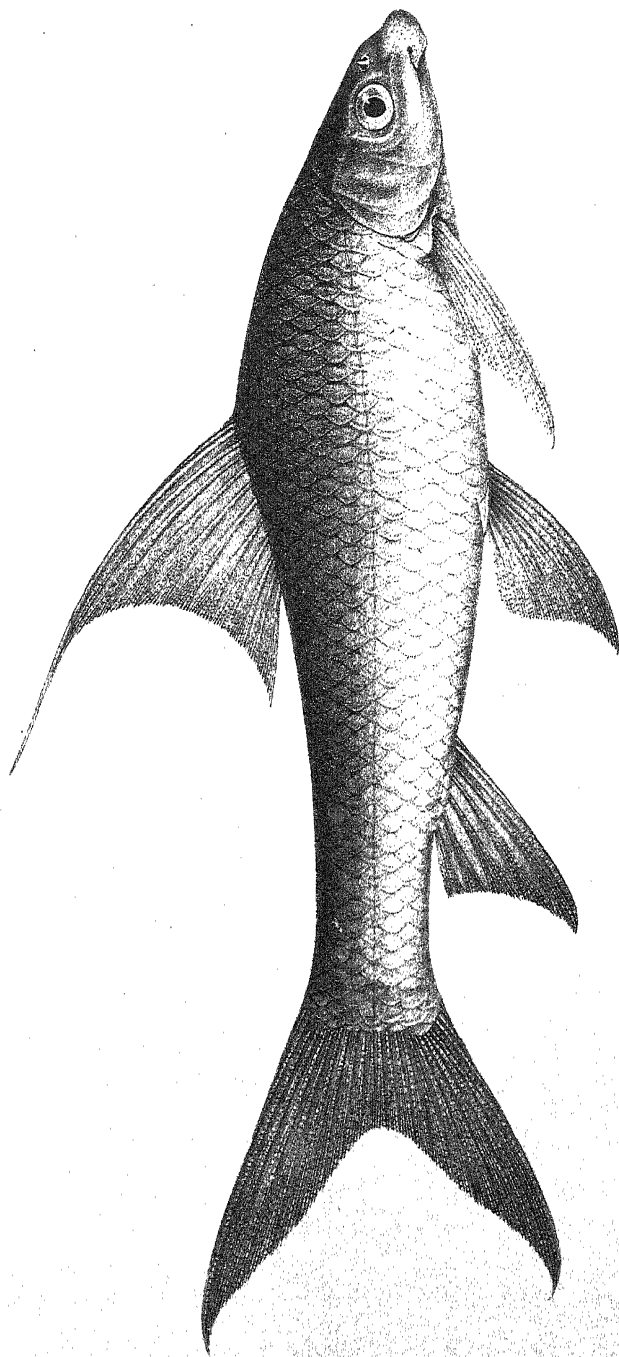
(Plates LXXVIII.-LXXX.†)

Systematic :	INDEX.	Page
<i>Labeo percivali</i> , sp. n. ....		673
<i>Barbus argyrotenia</i> , sp. n. ....		674
<i>B. minus</i> , sp. n. ....		674
<i>Amphilius oxyrhinus</i> , sp. n. ....		675
<i>Tilapia percivali</i> , sp. n. ....		676

The collection here reported upon, presented to the British Museum by Mr. Blayney Percival, is of special importance as coming from a district the fishes of which had not been collected before, from a watershed of its own without any communication with sea. The river called Eusso Nyiro, or Guaso Nyiro, quite distinct from the Southern Guaso Nyiro in German East Africa, takes its source to the east of Lake Baringo, separated from it and from Lake Rudolf by hill-ranges 1000 to 1500 feet higher (4000 to 5000 feet above sea-level) and is lost in the Lorian

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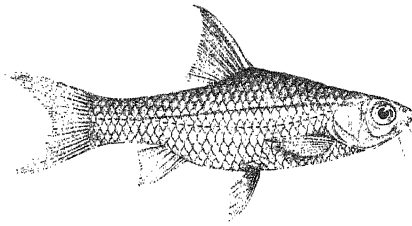
† For explanation of the Plates see p. 676.



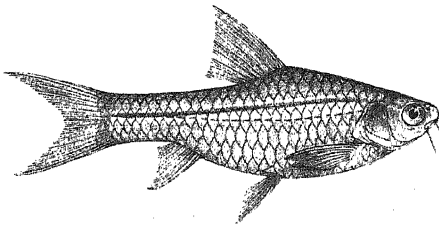
LABEO PERCIVALI.



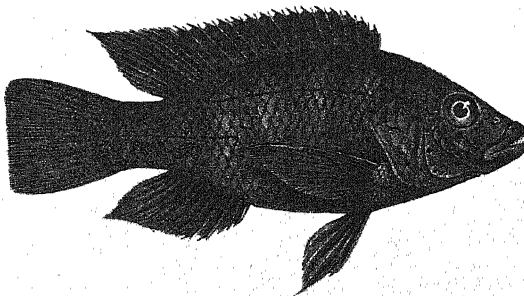




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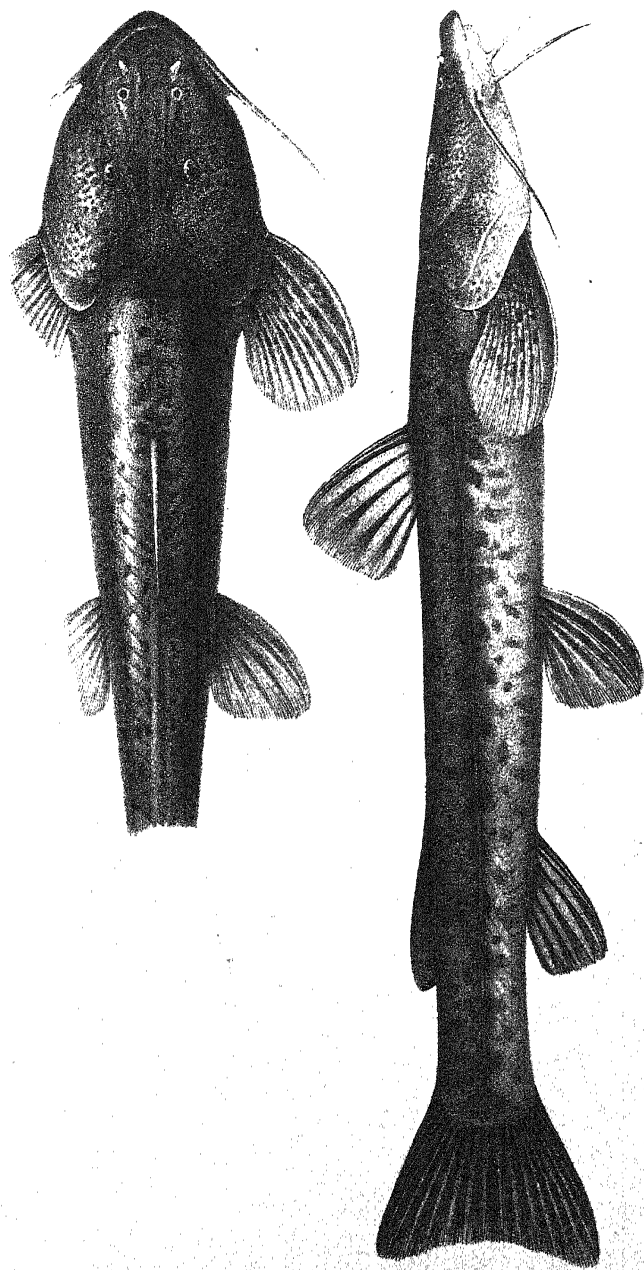


3.

J. Green del. et lith.

1. BARBUS ARGYROTÆNIA.    2. B. MIMUS.  
3. TILAPIA PERCIVALI.





J. Green del et lith.

AMPHILIUS OXYRHINUS.



Swamp. The Eusso Mara is a tributary of the Eusso Nyiro. The Saya is a separate river, between the Anagata Borita and the Eusso Nyiro, flowing north and lost in a small swamp some 50 miles north of Eusso Nyiro. Unless otherwise stated, the fishes here listed were obtained in the Eusso Nyiro, below the falls.

The fishes of this basin have much in common with those of the Webi Shebeli and Juba, and nothing with those of Lake Rudolf. Curiously, the small *Barbus*, *B. nairobiensis* and *B. percivali*, previously discovered by Mr. Percival in the Nairobi (Athi River system), on the east side of Kilimanjaro, were found again in abundance in the Eusso Nyiro.

1. *MORMYROPS DELICIOSUS* Leach.

2. *MORMYRUS KANNUME* Forsk.

3. *LABEO PERCIVALI*, sp. n. (Pl. LXXVIII.)

Body strongly compressed, its depth  $3\frac{1}{3}$  to  $3\frac{2}{3}$  times in total length. Head 4 to  $4\frac{3}{4}$  times in total length,  $1\frac{1}{2}$  to  $1\frac{2}{3}$  times as long as broad; snout rounded,  $\frac{1}{3}$  length of head; eye perfectly lateral,  $2\frac{2}{3}$  (young) to  $3\frac{2}{3}$  times in length of head; interorbital width  $\frac{1}{2}$ , or a little over  $\frac{1}{2}$ , length of head; lips with small papillæ forming transverse plicæ; lower lip with a fringe of large papillæ; rostral flap moderately large, with entire or indistinctly denticulate edge; a small barbel in the corner of the mouth. Dorsal III 10-11, equally distant from end of snout and from root of caudal, or slightly nearer the former; upper edge concave; last simple ray in adult males much produced, twice, or nearly twice, as long as head, not or but little longer than head in females and young. Anal III 5, reaching or nearly reaching root of caudal. Pectoral considerably longer than head in males, reaching base of ventral, the first ray of which falls below fourth or fifth branched ray of dorsal, shorter in females. Caudal deeply emarginate, with long, pointed lobes. Caudal peduncle  $1\frac{1}{3}$  to  $1\frac{1}{2}$  times as long as deep. Scales 38-42  $\frac{7\frac{1}{2}}{8\frac{1}{2}-9\frac{1}{2}}$ , 5 between lateral line and root of ventral, 18 round caudal peduncle. Silvery, back brownish grey; vertical fins greyish.

Numerous specimens, measuring 55 to 190 mm.

Allied to *L. neumanni* Blgr. Well distinguished by the larger eye and the shape of the dorsal in the males.

4. *LABEO CYLINDRICUS* Peters.

Also from the Eusso Mara and the Saya, and the Lorian Swamp.

5. *DISCOGNATHUS DEMBEENSIS* Rüpp.

Also from the Eusso Mara and the Saya.

6. *BARBUS ERLANGERI* Blgr.

Also from the hot springs at Chandler Falls, upper Eusso Nyiro, and from the Saya.

7. *BARBUS NAIROBIENSIS* Blgr.

From the Eusso Nyiro above the falls.

8. *BARBUS PERCIVALI* Blgr.

From the above locality, and also from the Saya.  
The largest specimen measures 105 mm.

9. *BARBUS ARGYROTÆNIA*, sp. n. (Pl. LXXIX. fig. 1.)

Depth of body  $2\frac{3}{4}$  to 3 times in total length, length of head  $3\frac{1}{2}$  to  $3\frac{3}{4}$  times. Snout rounded, shorter than the eye, which is  $2\frac{2}{3}$  to 3 times in length of head and equals or nearly equals interorbital width; mouth small, subinferior; lips feebly developed; two barbels on each side, anterior about  $\frac{2}{3}$  diameter of eye, posterior as long as or slightly longer than eye. Dorsal III 8, equally distant from posterior border or centre of eye and from base of caudal, border feebly concave; last simple ray enlarged, bony, strongly serrated behind. Anal III 5, not reaching caudal. Pectoral a little shorter than head, not reaching ventral; base of latter below origin of dorsal. Caudal peduncle a little longer than deep. Scales radiately striated, 30–31  $\frac{5\frac{1}{2}}{5\frac{1}{2}}$ , 3 between lateral line and ventral, 14–16 round caudal peduncle. Pale sand colour, with a silvery lateral band which is sometimes edged above with a streak of black pigment; fins white, often tinged with pale orange at the base.

Total length 53 mm.

Numerous specimens from the Eusso Nyiro below the falls. *B. argyrotænia* stands nearest to *B. zanzibaricus* Peters.

10. *BARBUS MIMUS*, sp. n. (Pl. LXXIX. fig. 2.)

Depth of body  $2\frac{1}{2}$  to  $2\frac{3}{4}$  times in total length, length of head  $3\frac{1}{2}$  to 4 times. Snout rounded, much shorter than the eye, which is  $2\frac{1}{2}$  to 3 times in length of head and equals interorbital width; mouth small, subinferior; lips feebly developed; two barbels on each side, anterior about  $\frac{2}{3}$  diameter of eye, posterior a little longer than eye. Dorsal III 8, equally distant from posterior border or centre of eye and from base of caudal, border feebly concave; last simple ray not enlarged, not serrated, as long as or a little longer than head. Anal III 5, not reaching caudal. Pectoral as long as head, not quite reaching ventral; base of latter below origin of dorsal. Caudal peduncle as long as deep or a little longer than deep. Scales radiately striated, 25–26  $\frac{3\frac{1}{2}}{3\frac{1}{2}}$ , 2– $2\frac{1}{2}$  between lateral line and ventral, 12 round caudal peduncle. Pale sand-colour, with a silvery lateral band, which is sometimes

edged above with a streak of black pigment; fins white and transparent, or pale orange at the base.

Total length 55 mm.

Numerous specimens from the Eusso Nyiro below the falls.

Closely allied to *B. neglectus* Blgr. from the Nile, and strikingly resembling the preceding species in general appearance, although differing widely in the feeble, non-serrated last simple dorsal ray and in the much lower number of scales.

11. *CLARIAS LAZERA* Lacep.

Eusso Nyiro, near the Lorian Swamp.

12. *EUTROPIUS DEPRESSIROSTRIS* Peters.

13. *BAGRUS UROSTIGMA* Vincig.

Eusso Nyiro, above the Chandler Falls.

14. *CLAROTES LATICEPS* Rüpp.

15. *AMPHILIUS GRANDIS* Blgr.

16. *AMPHILIUS OXYRHINUS*, sp. n. (Pl. LXXX.)

Depth of body 6 times in total length, length of head  $3\frac{3}{4}$  times. Head much depressed, slightly longer than broad; snout pointed,  $\frac{1}{2}$  length of head; eye very small, 11 times in length of head,  $2\frac{2}{3}$  times in interorbital width; posterior nostril midway between eye and end of snout; maxillary barbel  $\frac{2}{3}$  length of head, reaching root of pectoral; outer mandibular barbel  $\frac{2}{3}$  length of head, inner nearly  $\frac{2}{3}$ . Gill-rakers rather long, 7 on lower part of anterior arch. Dorsal I 6, much nearer end of snout than root of caudal. Adipose dorsal low,  $3\frac{1}{2}$  times as long as deep, twice as long as rayed dorsal, its length  $\frac{2}{3}$  its distance from latter. Anal III 5. Pectoral a little more than  $\frac{2}{3}$  length of head. Ventral a little shorter than pectoral, far behind base of dorsal. Caudal feebly emarginate. Caudal peduncle  $1\frac{1}{2}$  times as long as deep. Reddish brown above, spotted with blackish, dirty white beneath.

Total length 195 mm.

Distinguished from *A. grandis* by the pointed snout, the longer caudal peduncle, and fewer anal rays.

A single specimen from the Eusso Mara, a swift mountain-stream.

17. *SYNODONTIS SCHALL* Bl. Schn.

18. *SYNODONTIS GELEDENSIS* Gthr.

From the Eusso Nyiro, close to the Lorian Swamp.

19. *TILAPIA NILOTICA* L.

From the Eusso Nyiro, above and below the falls.

20. *TILAPIA PERCIVALI*, sp. n. (Pl. LXXIX. fig. 3.)

Depth of body equal to length of head,  $2\frac{1}{2}$  times in total length. Head about twice as long as broad; snout rounded, with straight or slightly convex upper profile, a little broader than long,  $\frac{3}{4}$  post-ocular part of head; eye  $3\frac{1}{2}$  (young) to 4 times in length of head, greater than præorbital depth; mouth large,  $\frac{3}{4}$  width of head, extending to below anterior border of eye; lips very strongly developed; teeth moderately slender, in 3 or 4 series, 40 to 50 in outer series of upper jaw; 2 series of scales on the cheek, width of scaly part rather less than diameter of eye. Gill-rakers short, 13 or 14 on lower part of anterior arch. Dorsal XIII-XV 11; spines increasing in length to the last, which measures  $\frac{2}{3}$  length of head; longest soft rays  $\frac{2}{3}$  length of head. Anal III (exceptionally IV) 9-10; third spine  $\frac{1}{2}$  length of head. Pectoral about  $\frac{3}{4}$  length of head, not reaching origin of anal. Ventral reaching vent or anal. Caudal rounded, subtruncate. Caudal peduncle deeper than long. Scales cycloid, 30-31  $\frac{3-3\frac{1}{2}}{12}$ ; lateral lines  $\frac{18-20}{13-16}$ . Dark brown, with black vertical bars on the body, or entirely black.

Total length 75 mm.

Hot springs at Chandler Falls, Northern Eusso Nyiro, 2500 ft. Caught in water about 100° Fahr.

Near allies of this new *Tilapia* are *T. alcalica* Hilgend. from alkaline water in volcanic holes near the Nguruman Salt Lake, into which the Southern Guaso Nyiro flows, on the boundary of British and German East Africa, and *T. grahami* Blgr. from Lake Magadé, a perfectly isolated hot soda lake in the Rift Valley, British East Africa, not far from the Southern Guaso Nyiro. The former has, like *T. percivali*, D. XIII 11, but the scales on the cheek are in two series and the caudal is truncate; the latter has D. XI 11-12, 3 series of scales on the cheek, and the caudal peduncle is deeper than long.

## EXPLANATION OF THE PLATES.

## PLATE LXXVIII.

*Labeo percivali*, p. 673.  $\frac{5}{8}$  nat. size.

## PLATE LXXIX.

- Fig. 1. *Barbus argyrotaenia*, p. 674.  
 2. " *mimus*, p. 674.  
 3. *Tilapia percivali*, p. 676.

## PLATE LXXX.

*Amphilius oxyrhinus*, p. 675.



38. Contributions to the Anatomy and Systematic Arrangement of the Cestoidea. By FRANK E. BEDDARD, M.A., D.Sc., F.R.S., F.Z.S., Prosector to the Society.

[Received April 2, 1912 : Read May 7, 1912.]

(Text-figures 92-101.)

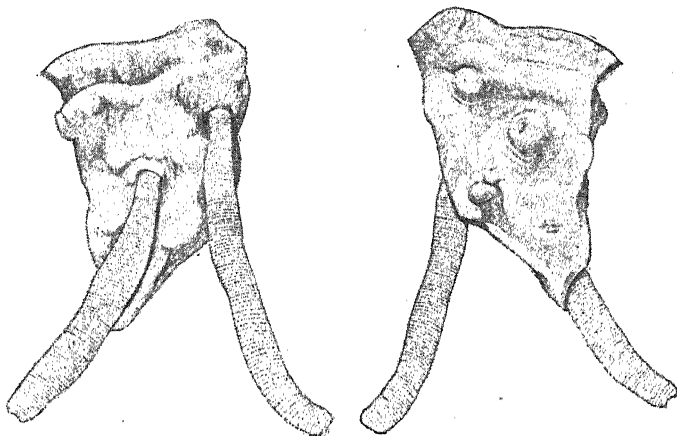
V. ON A NEW GENUS (*Dasyurotænia*) FROM THE TASMANIAN DEVIL (*Dasyurus ursinus*), THE TYPE OF A NEW FAMILY.

INDEX.

Systematic :	Page
<i>Dasyurotænia</i> , gen. n. ....	694
<i>D. robusta</i> , sp. n. ....	694
Résumé of anatomical points.....	695

The Cestoidea hitherto recorded from Marsupials appear to belong to the following genera only, viz. *Triplotænia*, *Moniezia*, *Bertiella*, *Linstowia*, *Anoplotænia*, *Oochoristica*, and *Cittotænia*. To these must now be added an eighth genus, of which I have recently examined examples from the Tasmanian Devil, in whose small intestine they occurred.

Text-fig. 92.



*Dasyurotænia robusta*, nat. size.

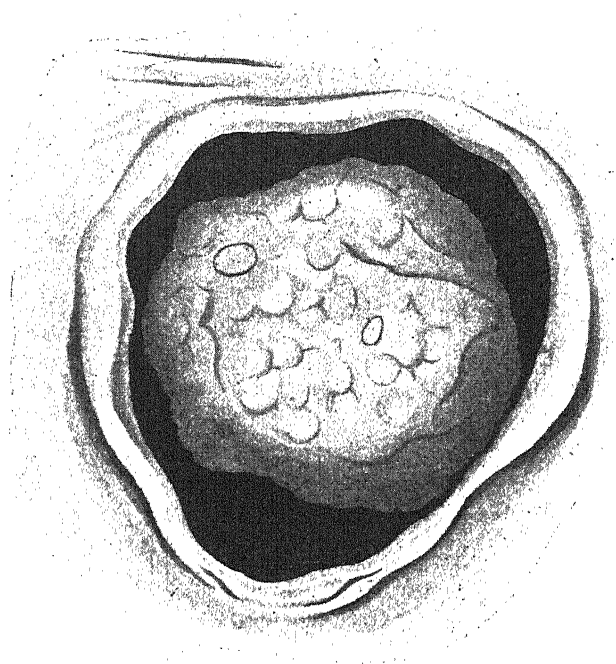
Two views of the same two specimens, to show their attachment to the gut.

The left-hand figure represents the interior of the gut, the right-hand figure the outside.

The accompanying drawings (text-fig. 92) show two of the three specimens which I obtained *in situ*. Each worm is firmly imbedded at the head end in the wall of the gut. The two

drawings show the inner surface and the outer surface of the intestine. The body of the worm is rather flat though at the same time fairly thick, and is curved in a sickle-like fashion. The length of the larger of the two individuals is about  $1\frac{1}{4}$  inches, and the greatest breadth does not exceed 5 mm. There is not a very marked difference in diameter at the neck end of the body, and the worm thus presents a very solid and strong appearance, which is correlated with the very firm way in which it is imbedded in the gut. The narrowness of the segments and the lack of overlap of successive segments contributes further to the stout appearance of the worm.

Text-fig. 93.

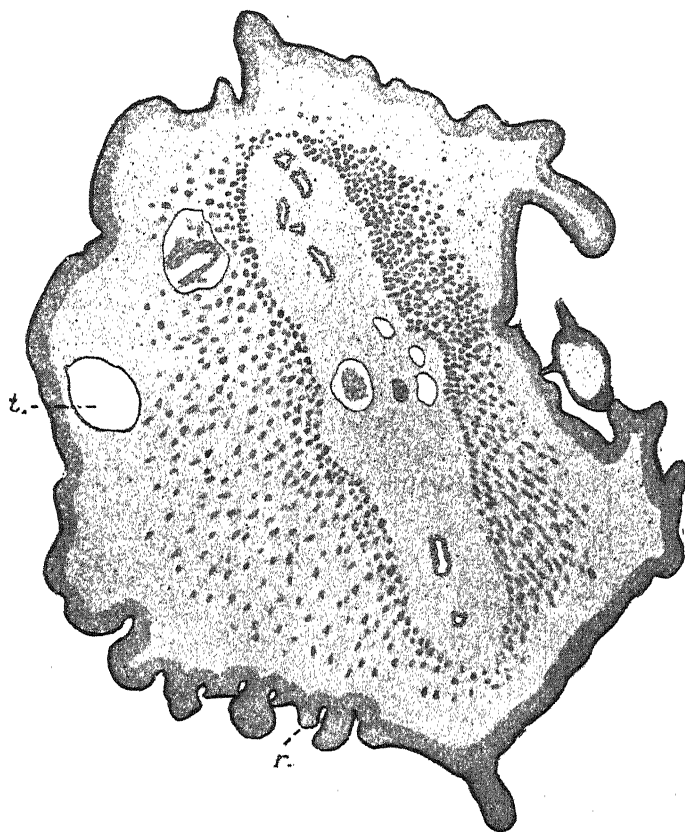


Head of scolex of *Dasyurotenia robusta*, shown by opening up the cyst on the gut.

The last two or three segments of the body are rather narrower from side to side and are curved, thus tending to encircle each other successively. This state of affairs is shown in the drawings referred to. Anteriorly the strobila is seen to perforate the wall of the intestine, which forms a fold round it, like a collar not fitting very closely. The strobila at this point disappears from view when the intestine is examined from its internal surface.

When the piece of gut to which the worms are attached is turned over they reappear on the outer surface (as is shown in text-fig. 92) in the form of a cyst. This cyst forms a simple hemispherical bulging upon the wall of the gut consisting apparently of the peritoneum. When this peritoneal wall is cut through a

Text-fig. 94.



Transverse section through scolex of *D. robusta* at about the middle.

The central medulla shows the problematical vesicles referred to in the text in the middle of its extent and the coils of the water-tubes at the ends.

*r.* Irregular furrows upon scolex. *t.* Tube formed by these.

A second tube of the same nature lies above and to the right of that lettered.

cavity is opened up in which lies the large scolex. This is illustrated in text-fig. 93. The scolex, it will be observed, does not completely fill the cavity in which it lies.

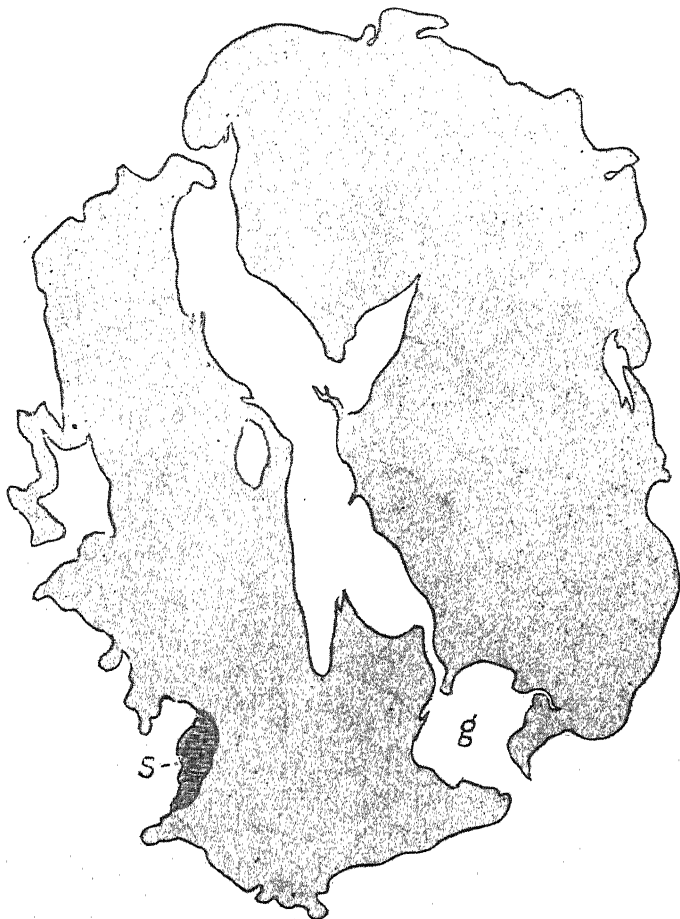
The large size of the scolex of *Dasysurotania* contrasts with the relatively small or even minute scolex of other Tetracotylea, and thus recalls that of the Tetrphyllidea and others of the "lower" groups of Tapeworms. So also do certain other characters of the scolex in this worm. The greatest diameter of the scolex is 3.5 mm., and it is of much the same length, so that its dimensions are but little less than the diameter and thickness of the body, and are greater than those of the neck-region which immediately ensues. Broadly speaking, the scolex is of a globular form and has a soft, easily indentable, irregular surface marked by faint ridges and depressions, and not at all like the vertex of a typical member of the Tetracotylea. Two flat plate-like areas are to be seen when the scolex is examined in this way with a pocket-lens. These are, as I believe, the expanded suckers which I have seen in a contracted condition in another specimen whose scolex was studied by means of transverse sections.

Transverse sections of the scolex (text-fig. 94, p. 679) are approximately circular in outline, in the middle part at any rate. This particular scolex, which I studied by the section method, was apparently more retracted than the one represented in text-fig. 93. For at first the sections (text-fig. 95) showed two semi-circular masses closely applied along the straight margin which is obviously the expression of an apical groove in the scolex. It was lower in the series than this that the contour of the sections became circular. At the body end of the scolex the latter slightly overlaps the neck for the whole of its circumference. But although the sections through the scolex are on the whole circular in form, the peripheral layer is not at all uniform and shows numerous processes and grooves occurring everywhere, which is an expression of the irregular grooving and ridging of the scolex apparent when that region is examined with a hand-lens. I could detect no symmetrical arrangement in these projections and grooves, which, however, may collectively represent "bothria" meandering over the surface of the scolex.

It is furthermore the fact that these grooves are converted in places into tubes which run along the interior of the peripheral layer of the scolex in a longitudinal direction, though not for a long distance. These short tubes end blindly. Their existence, together with the grooves and ridges of which they are a further development, must facilitate the adhesion of the scolex to the surrounding walls of the cyst. While the more or less irregular grooves and furrows upon the surface of the scolex might be put down to irregular contraction of its outer layer, this can hardly be the case—one would suppose—with these invaginated tubes. In any case the arrangement of the suckers does not conform to the arrangement usually met with among the Tetracotylea (to which group this worm would be *expected* to belong). The scolex, however, possesses four suckers which are of very small size when compared with the diameter and circumference of the scolex.

The greatest diameter of one of the suckers is not more than one-tenth the diameter of the scolex at its widest part.

Text-fig. 95.



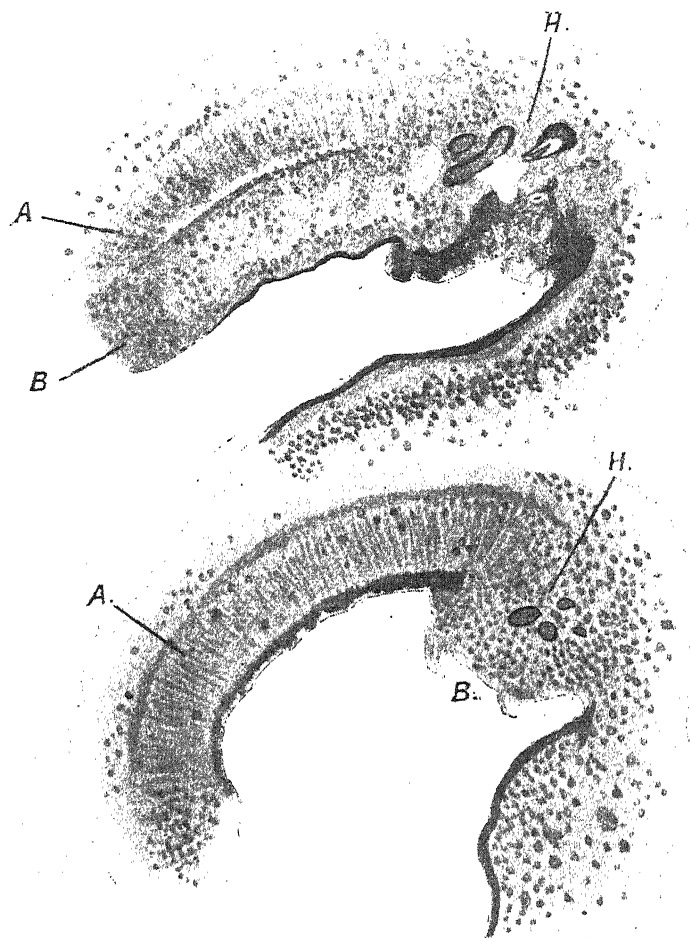
Section through apex of scolex to illustrate relative size of one of two smaller suckers (*s.*).

*g.* Median groove formed by retraction of sucker.

On either side of the apical groove already mentioned was a single cup-shaped sucker bearing hooks. I assume, therefore, that these two suckers are really anterior in the fully expanded condition of the scolex, and that they are the two disk-like bodies

described above in the scolex, which was examined entire and by the aid of a lens only. These two suckers were not exactly opposite on the opposite sides of the groove. They represent all that I can find in the scolex comparable to a rostellum. I believe, however, that they do not represent the rostellum of the *Tetracotylea*.

Text-fig. 96.



Two consecutive sections through one of two larger suckers bearing hooks.

*A.* Muscular layer of sucker. *B.* Cellular layer in which lie hooks (*H.*).

In these sections (text-fig. 96) the sucker appears cup-shaped, the orifice naturally opening into the median transverse groove

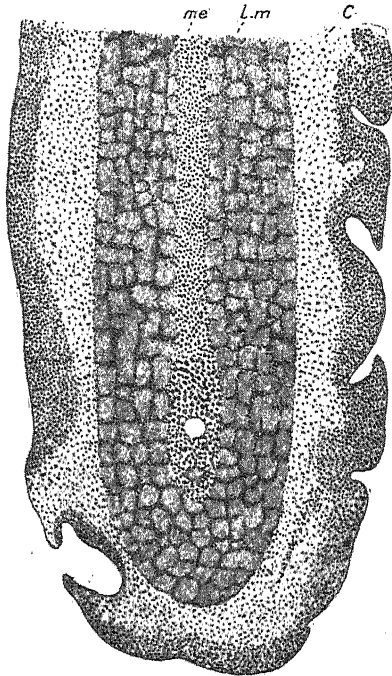
upon the scolex. The structure of the sucker is not like that of the typical Tetracotylean sucker. In the latter there is one thick layer of typically arranged muscle-fibres (into the nature of which arrangement it is not my purpose to enter—it is well known) which is quite distinct from the surrounding tissues of the scolex, but never covered by them on its free surface, which faces towards the aperture. In the present species the structure of this sucker is illustrated in the accompanying text-figure (text-fig. 96), which is drawn from one sucker only which appears to me to be rather larger than its fellow, the two being thus mutually asymmetrical. Examining the sections from below upwards, the sucker is seen at first to be apparently like that of the Tetracotylea generally. It consists of a strongly marked layer of muscle-fibres etc. lying in a cavity of the body parenchyma. This is shown in the figure. As we approach more nearly to the rostellar region, another layer in which the hooks are implanted pushes itself in front of the sucker proper, as is also shown in the text-figure referred to. This layer is continuous with and similar in structure to the general parenchyma of the head. The true (?) sucker thus gets as it were buried beneath a layer of tissue bearing hooks. So far the structure of this sucker will be plain from the sections figured. In the corresponding sucker of the opposite side of the body the hooks are obvious and quite similar, and imbedded in a perfectly corresponding tissue. But I could find no trace whatever of the muscular structure independent of these hooks.

In addition to these two suckers the scolex of *Dasysurotenia* possesses two others, thus making the normal four. The latter are roughly opposite to each other, but do not—obviously, at least—alternate with the others. These two suckers are opposite to each other and lie on the outside of the scolex, and are about on a level with the hooked suckers already described. It is quite possible that when the scolex is fully expanded and not warped through unequal contraction with alcohol, the four suckers might alternate with more regularity than is apparent in my preparations. In any case, these suckers are quite different from those already described. They are smaller than, at any rate, the larger of the more apically placed suckers; and there is no trace whatever of any hooks associated with them. Each appears (see text-fig. 95) in section to have the form of a flat disk. Their structure seems to be quite like that of suckers generally among Tapeworms. What is very apparent about these suckers is their very small size compared with the wide periphery of the scolex. I could not detect them at all on an examination of the scolex with a lens (see text-fig. 93, p. 678).

We have next to consider the histological structure of the scolex, which presents certain peculiarities. The anterior region of the scolex has no distinction into medullary and cortical layers. The commencement of such a differentiation is marked by the

depth of the invagination of the anterior end of the scolex referred to above. This part of the scolex presents a very lax appearance in sections, which is doubtless to be correlated with the irregular outline of the scolex. Through this lax tissue stray in every direction muscle-fibres which no doubt effect the retraction of this anterior part of the scolex. The main mass of tissue in which the muscular fibres run has the usual amorphous ground-substance of the Cestoid body with many nuclei; but I have not made a particular histological study of these tissues.

Text-fig. 97.



Part of transverse section through neck-region of *Dasysurotænia robusta*.

C. Cortical layer outside of longitudinal muscles (*l.m.*).

me. The thin medullary layer.

Further back in the scolex the medullary region appears as quite distinct from the cortical. In the latter the muscular fibres gradually collect into a massive bundle of longitudinally running fibres which immediately surround the medulla and occupy a great deal of the cortex. Within the scolex there is no subdivision of this muscular mass into bundles such as I shall



describe in the strobila and even in the neck-region of the same. In the medullary region at either end is to be seen the water vascular tube, which is here rather coiled, a tube appearing five or six times in a single cross section. In the middle of the medullary area are certain remarkable structures, which are represented in text-fig. 94 (p. 679). These are apparently hollow spheres excavated in the parenchyma but with very definite walls. These vesicles contain lumps of an amorphous matter into the nature of which I have not enquired. There is no connection that I could find between these vesicles and the water vascular system. I am quite uncertain as to their nature.

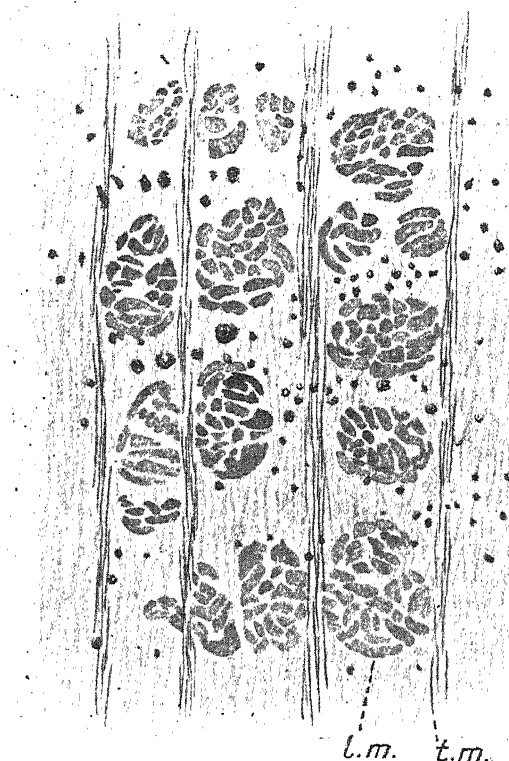
The neck-region of the worm after it has issued from the cyst which contains the scolex is represented in transverse section in text-fig. 97. It will be observed at once that the medullary parenchyma is very greatly reduced. It forms a thin layer very much narrower than the extremely thick cortical layer. Nor could I discern in it the typical retiform appearance of the Cestoid medullary parenchyma with spherical masses of granular matter lying between the meshes of the network. The whole of the available space, save between the individual testes at the two sides of each proglottid, is occupied by the rudimentary female organs, which together with the testes seem to occur in the very first segments. The whole space thus occupied by the generative masses and by what remains of the medullary parenchyma is not one half of the diameter of the cortex. It has been already pointed out that at the posterior end of the scolex, a little before it merges with the neck, the medulla is surrounded by a very thick layer of muscles composed of large fibres. In this layer no marked arrangement of the fibres into bundles could be made out. But in the next few sections, which we here speak of as the neck, these fibres are very definitely disposed in a series of bundles (text-fig. 98).

These bundles are disposed in four to six layers, and at the two lateral extremities of each segment they are rather more numerous than medianly. The bundles consist of a large number of individual fibres, often as many as sixty or so. They are separated from each other by a dense nucleated tissue. Later in the body we have the same four to six rows of bundles of fibres; but in these latter segments each row is separated from those which lie above and below it by a delicate layer of transverse fibres. These fibres are not apparent in the neck-region. I imagine that this enormously powerful muscular system is correlated with the distance to which the scolex is enabled to force itself into the wall of the intestine of its host. These rows of bundles of longitudinal fibres are reminiscent of what is characteristic of the family Acoleidæ, as is to be seen, for example, in the genus *Proterogymotaenia*,\* where they have been figured by

\* Abh. Senck. Ges. 1911, p. 260, fig. 14.

Fuhrmann. Outside of these layers of fibres the cortex presents no features which differentiate it in any marked way from other allied forms.

Text-fig. 98.



Section through the muscular layer of the cortex, taken at a point further back than that represented in text-fig. 97.

*l.m.* Bundles of longitudinal fibres. *t.m.* Transverse fibres.

The water vascular system of this tapeworm is in more than one respect remarkable. In transverse sections through the ripe proglottids only two vessels are as a rule visible, one on each side of the body. The most careful examination often failed to reveal the presence of another, even minute, tube. Nor did longitudinal sections show any trace of this second vessel. It is not, however, really absent in this worm, as I found it to be in *Thysanotenia lemuris*, for it is present as a very minute tube in some segments. The vessels which are obviously present

are of very large size, and it appeared to me that that on the pore side of the segment was a little the larger of the two. This, then, is the first important point about these vessels, *i. e.* that there is a very large ventral tube on each side of the body and a very minute dorsal tube. In following out a series of transverse sections, it is seen that the lumen of the large ventral water-vessels is occasionally occluded by a delicate diaphragm-like sheet of membrane which is abundantly nucleated. There is no question of a narrowing of the calibre of the tube, but of an actual membrane which extends partly across it here and there.

In sagittal sections the existence of these membranes stretching partly across the lumen of the water vascular tube is quite obvious. They occur, moreover, on both sides of the body, that is to say in the case of both ventral tubes. The reason for emphasizing this fact will be apparent later. In the longitudinal sagittal sections referred to it will be seen that there are several of these membranes which stretch a good way across the water-vessel, and though two membranes arising from different sides of the vessel do not actually meet, the edge of each stretches beyond the edge of the other, so that the tube would appear, when viewed in the direction of its length, to be entirely occluded. It is noteworthy that these diaphragms, so to speak, arise indifferently from both sides. The exact arrangement will be plain from the annexed drawing (text-fig. 99, p. 688). I have noticed that in some of the posterior proglottids the lumen is actually occluded once in each proglottid. The two ends of two oppositely projecting membranes are connected by a continuous though very thin membrane which connects the thicker extremities of the lateral projections. This median part appears to be nowhere deficient, and the water vascular system is thus divided up in these regions of the body into a series of chambers.

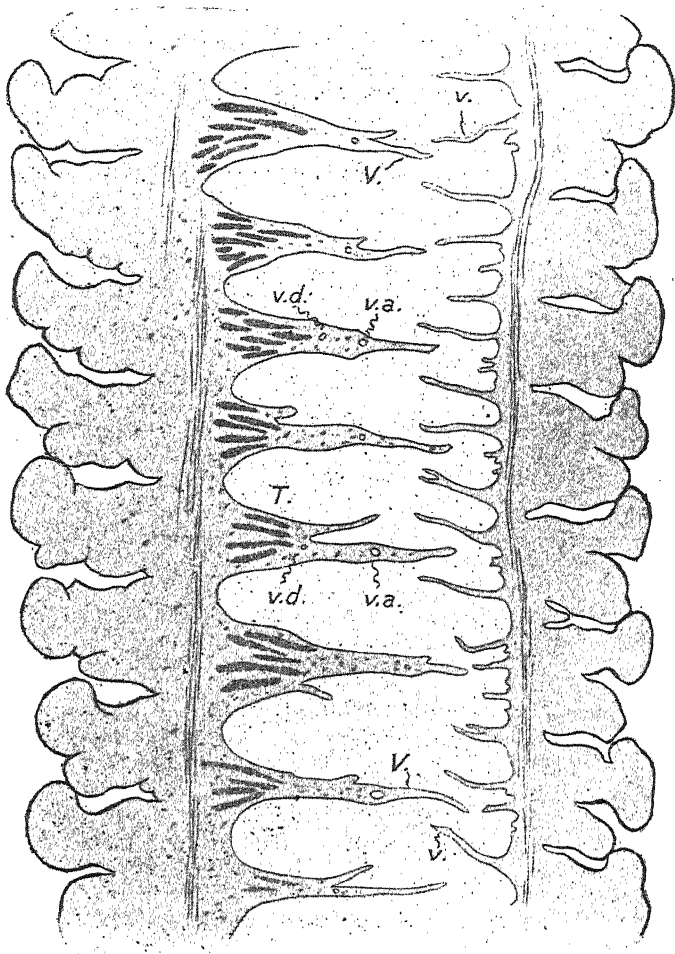
I presume that these numerous membranes stretched across the large vessels correspond to what has been figured in other tapeworms as valves. I have emphasized the fact that they occur on both sides of the body, because they carry on the pore side the genital ducts which actually perforate their substance and lie in their thickness. This perforation is limited to the larger of these valve-like structures which arise from the outer side, and it has been produced I imagine by the extension round the ducts of the water-vessel, which is of much greater diameter in the posterior than in the most anterior segments. In the case of these latter, as already mentioned, the generative ducts pass to one side of the water-tube.

Another important feature in the water vascular system of this tapeworm is the total absence of transverse vessels uniting the longitudinal trunks in such segments. This state of affairs is not unknown among other Cestoidea—it occurs, for example, in *Hymenolepis acuta* \*—but it is not common. Nor is this lack of

\* v. Janicki, Zool. Anz. Bd. xxvii. 1904, p. 776.

transverse vessels compensated by any network of excretory tubes pervading the medulla, such as is met with in the genera *Inermicapsifer* and *Zschokkeella* \*.

Text-fig. 99.



Sagittal section to illustrate ventral water vascular tube.

V. Projecting valves. v.d. Vas deferens. v.a. Vagina.

T. Testes.

\* Beddard, P. Z. S. 1912, p. 596, and literature quoted there.

The *Generative organs* of this tapeworm begin to be recognisable very early in the body, only a segment or two behind the head. But it is a long way back before the ovaries are ripe. As in the vast majority of Cestoidea, the testes ripen earlier than the ovaries. This being the case, the testes are recognisable earlier as distinct bodies, and only cease to be so clear in the more posterior segments, where the uterus is gorged with eggs. A remarkable point of interest in the generative organs is the fact that the duct leading to the exterior, or to be more exact the formative mass of cells which will be both vagina and cirrus sac, is seen to alternate in position in relation to the single water vascular tube and the nerve-cord. In all segments the actual opening is on the same side of the body, but the generative duct passes towards it either between the water-tube and the nerve-cord or outside of both; in the latter case only to one side—there is no alternation between a dorsal and a ventral position. We shall see, when the cirrus sac and vagina come to be described later, that there is also variation in the exact relationship in position between these two.

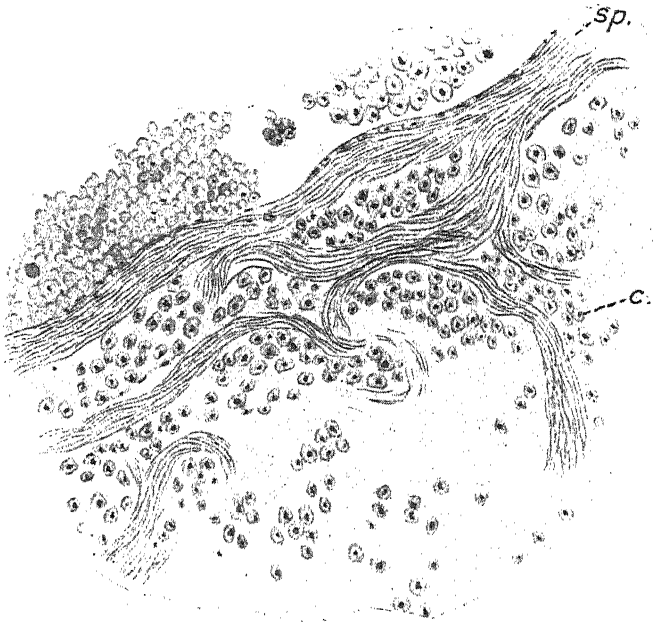
The *ovaries* are large and consist of two wings, which are symmetrical or very nearly so, the middle point between them being the middle line of the body, where are situated the shell-gland etc. The ovaries are posterior in the segment, and behind them lie the *vitelline glands*. These latter are of much the same shape as the ovaries, and in rather immature segments differ only from them by their rather darker staining with hæmatoxylin. They also form two wings symmetrical with their middle point, and are in contact with the ovaries in front. The two glands are composed of many lobes, which reach as far as the testes at the sides; altogether an ovary occupies fully half of the segment, and rather more when it is fully mature. Immediately in front of it are the sperm-duct and vagina. At the sides are to be found the testes, which are also dorsal to it.

The *vagina* offers no very remarkable character. It has at first a contracted lumen, which widens out for a considerable space, and then contracts again before it suddenly opens into the rather pear-shaped receptaculum seminis. The course of the vagina is quite straight between its two ends and oblique in direction. The narrow part of the vagina which opens into the receptaculum is of some length, but shorter than the wider part. The vagina shows quite the same characters in the most mature proglottids. The receptaculum seminis is full of spermatozoa, and very frequently contained ova at its wider end, close to where the oviduct opens into it. The receptaculum and the vagina lie anteriorly in the segment in front of the ovary, but behind the uterus.

The *uterus* of this worm is persistent and found as a large cavity extending right across the segment in the most mature proglottids that I have examined. It begins as a small rounded cavity lying in the front part of each segment.

The *testes* of this worm are chiefly massed at the two sides of the proglottid, but these two masses are connected by a string of testes which pass dorsally along the proglottid. They therefore nearly surround the ovary and the female organs generally, so far partly resembling *Cyclorchis*. In transverse sections the testes appear circular in section; but sagittal sections such as that represented in text-fig. 99 (p. 688) show that the form of the testes is that of a flat plate, for in those sections they appear more linear in shape. These sections also show quite plainly that each testis

Text-fig. 100.



A portion of the coil of the sperm-duct (*sp.*) gorged with sperm.

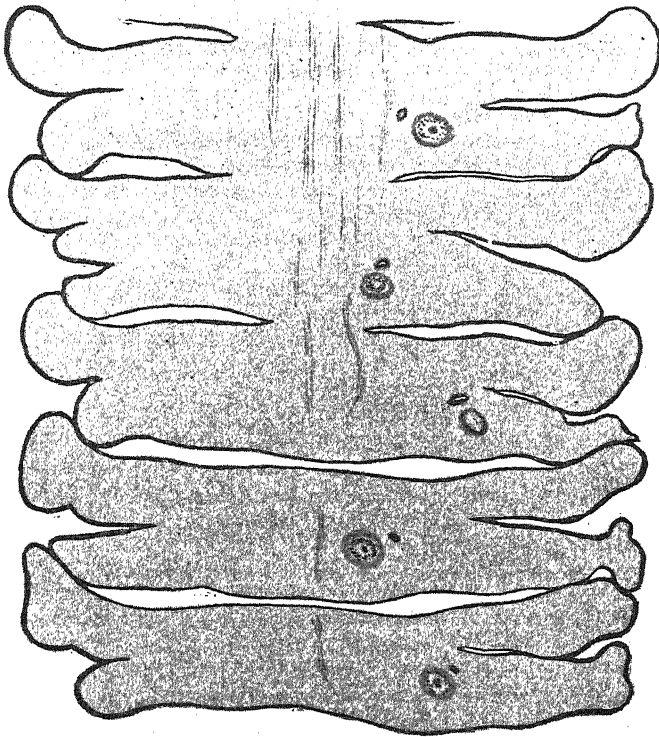
*c.* Interstitial prostatic cells.

lies in a space, unless, indeed, the appearances produced are due to shrinkage through reagents. In any case, however, the testes of these worms frequently present the appearance of being surrounded by the spermatozoa which they produce, thus showing that a chink exists or can be formed for their reception when pressed out of the testis. The testes are very numerous and quite crowded together,—so much so that the delimitations between successive segments so far as concerns these organs

are not at all visible in sagittal sections; they appear as a continuous mass.

The *sperm-duct* runs straight for a short way after it has left the cirrus sac. It forms a copious coil (text-fig. 100) occupying the middle of the body and lying partly dorsally to the receptaculum seminis and rather nearer to the pore side of each proglottid. The rest of the coil—that part which is nearest to the cirrus sac—is

Text-fig. 101.



Sagittal section showing in consecutive segments the varying relations of cirrus sac (the larger tube) and vagina.

to the pore side of the receptaculum, and therefore ventral in position. In fact, regarded as one coil, this region appears oblique in direction in transverse sections of the proglottids. Between the individual loops of the sperm-duct are cells which quite fill up the interstices, and are thus numerous in proportion to the width

of those interstices. The cells are rather clear, with well-stained nuclei. They correspond exactly, as it seems to me, with the prostatic cells of *Inermicapsifer* and *Zschokkeella*, dealt with in these genera by v. Janicki\* and myself †, and which appear to occur also elsewhere. In immature segments the cells bulk more largely than the coils of the sperm-duct. But the reverse is the case in the mature proglottid.

The *genital ducts* open into a common *cloaca genitalis*, which in its turn opens on to the exterior. The *cloaca genitalis* is of some depth, but it is not borne upon any process of the body. Into it open, close together, the vagina and the cirrus sac, whose mutual relations I have investigated by means of sagittal sections (text-fig. 101) through portions of the strobila. There is a considerable variation in these relations. Although the vaginal pore is apparently never in front of the male pore, it is not always directly behind the male pore. The commencing vagina lies obliquely behind the commencing cirrus sac—the direction of the obliquity being now dorsal now ventral in this segment and in that. There is, in fact, an irregular alternation from segment to segment; sometimes the two tubes are not merely oblique, but actually dorsal or ventral to each other as the case may be, lying therefore side by side in sagittal sections. This recalls to mind the alternation that occurs in certain (but not all) species of the genus *Moniezia*, where the vagina may be dorsal or ventral to the cirrus sac. But in this latter genus the alternation is of the right and left set of generative organs of a single segment.

The *cirrus sac* of this tapeworm is large and has the very common flask-shape. The neck-region has very thick circular muscular walls, forming a sheath which thins out over the more distended region of the sac. In less mature segments (in which, however, the testes are fully developed, though with no mature spermatozoa) the cirrus sac is elongated, gradually diminishing in breadth towards the external pore; there is no marked division into neck and flask. It is very long and extends towards the middle line of the body, a little beyond the water vascular tube of its side of the body, or at least reaches the internal side of that tube. The cirrus runs straight from end to end of the cirrus sac and anteriorly presents a moniliform appearance, which is due to successive dilatations of the lumen of the cirrus. This region of the cirrus is both preceded and succeeded by a perfectly straight section of that tube with very narrow lumen and thick walls.

In later segments the cirrus sac acquires the flask-shape already referred to. Coincidentally with this is an actual shortening of the length of the entire sac and a coiling of the cirrus within it. The cirrus sac in these and in subsequent segments hardly reaches beyond the outer edge of the water vascular tube. It seems clear therefore that the shortening is due to an actual contraction of

\* Denkschr. Ges. Jena, xvi. 1910.

† P. Z. S. 1912, p. 602.



the length caused by a bulging of the walls of the cirrus sac due in its turn to the rapid growth and consequent coiling of the cirrus. When the cirrus sac is in this fully formed condition, the cirrus itself is differentiated more thoroughly into those regions less markedly indicated in earlier stages. The sperm-duct enters the cirrus sac at the apex and its lumen contracts to a fine line for a short space near to its entry. This is particularly obvious in the last few segments of the body, where the sperm-duct has become much dilated before its entry into the cirrus sac, and thus offers a greater contrast to this exceedingly narrow region.

In these more mature cirrus sacs the flask-shape has been acquired, as already mentioned. But the neck of the flask is much longer than the body part. The latter is so fully occupied by the coils of the cirrus itself that there is but little of the interstitial packing tissue to be seen. At its entry into the cirrus sac and for a considerable time thereafter the duct is thick-walled, with a very narrow lumen, and much coiled. This region of the cirrus is succeeded by a not very long but coiled tract, which is much wider and has thinner walls. The lining membrane bears numerous spinelets. Finally, the distal region of the cirrus is again thick-walled and with a narrow lumen: it opens into the genital cloaca without any alteration of character. In the most posterior segments of the body the greater part of the cirrus sac is filled with sperm, the posterior region alone showing a group of coils of the cirrus. Whether the anterior part of the cirrus has become ruptured, as it appeared, or has been simply enormously expanded and its walls reduced to extreme tenuity by the enclosed sperm, I am unable to say.

The systematic position of this tapeworm is difficult to fix with any confidence. The generative system, and, indeed, the internal anatomy generally, presents no differences of importance from many *Tetracotylea*; and there are, indeed, no reasons so far why the worm should not be placed in the *Anoplocephalidae*, which family, as has been pointed out, contains nearly all the Marsupial tapeworms. On the other hand, the very much developed layers of longitudinal muscles in the body-wall suggest the family *Acoelidae*. The difficulty, however, of accurately placing the worm lies in the peculiarities of the scolex. There is no doubt that it contrasts very considerably with the general form of the scolex among the *Tetracotylea* in a number of points, of which the principal ones are:—(1) its large size, both relatively to the body and actually; (2) the presence of numerous grooves which cannot be, at any rate, entirely artefact, as they are converted here and there into tubes running within the thickness of the head; (3) the relatively minute size of the four suckers and the fact that two of them and two only are furnished with hooks\*.

\* Furthermore, these hooks are distinctly hollow at their broader end, "like a Ruminant's horn," as Shipley (Willey's *Zool. Res.*, Entozoa, 1900) notes of *Calliobothrium*, one of the *Tetraphyllidae*.

These characteristics are collectively different from anything met with among the Tetracotylea that is known to me. They are not, however, inconsistent with the conditions known to occur among the Tetraphyllidea, if we may admit the grooves upon the scolex to represent the bothria of such tapeworms. The suckers would then correspond with the small accessory suckers so frequently possessed by these latter worms, and their small size relatively to the scolex would be thus intelligible. The apparently numerous bothria not reducible (by me) to symmetry is suggestive of a type like *Phyllobothrium*\* slightly modified, or perhaps *Peltidocotyle*†. We cannot, however, place *Dasyurotænia* among these Tetraphyllidea on account of the Tetracotylean character of its yolk-gland. But with reference to this gland it may be borne in mind that it is in structure much more diffuse than is usual with the generally solid vitelline gland of the Tetracotylea.

The genus may be thus defined :—

*Dasyurotænia*, gen. nov.

*Stoutly built worms with large scolex bearing four small suckers, of which the inner two bear hooks. No rostellum, but anterior end of scolex, including hooked suckers, retractile. Segments very short. Inner layer of (longitudinal) muscles very thick, consisting of four to six rows of bundles of fibres. Ventral excretory tubes large, with numerous valves not communicating with each other in the strobila. Dorsal vessels minute, not always visible. Genital pores unilateral. Testes numerous, chiefly lateral, anterior, and dorsal. Vas deferens with a large coil in middle of segment surrounded by prostatic cells; cirrus sac large, cirrus with spinelets. Ovaries with two wings, median‡ and posterior and ventral in position, in front of vitelline gland, which is also symmetrical. Shell-gland median, dorsal. Receptaculum seminis present, nearly median, ventral. Uterus sac-like, persistent, fills nearly whole of ripe proglottid. Eggs thin-shelled.*

*Hab. Marsupials.*

The species I term "*robusta*" on account of its very stout build. It is, however, quite impossible for me to venture upon an enumeration of the peculiar specific characteristics for the present.

This genus and species cannot, as I think, be identified with any other form that has been described from an Australian Marsupial. From the present genus we only know a species described by myself § a little time since as *Anoplotaenia dasyuri*. Nor can I identify it with any of the genera enumerated at the beginning of this paper in other Marsupials. In fact, *Bertiella* is

\* Bronn's 'Thierreich,' Bd. iv. Cestoiden, pl. xli. fig. 10.

† *Ibid.* pl. xliii. fig. 1.

‡ Middle line of female apparatus only slightly displaced towards pore side.

§ F. Z. S. 1911, p. 1003.

the only one of these genera to which it bears any likeness in the reproductive system, and from this genus the characters of the scolex at once distinguish *Dasyurotenia*. Indeed, its inclusion among the Tetracotylea (=Tænioidea) is not, to my mind, an obvious certainty. In any case the hooked suckers exclude it from the family Anoplocephalidæ, to which nearly all the Marsupial tapeworms belong up to the present.

The most salient points of anatomical interest in this worm appear to me to be the following :—

(1) The immense size, relatively speaking, of the scolex and the small size in comparison with it of the suckers. The fact that two suckers are armed with hooks while the other two suckers are not so armed.

(2) The great thickness of the longitudinal muscles, which consist of at least four layers of bundles each containing very many individual fibres of considerable stoutness.

(3) The existence for the most part of only a single water vascular tube on each side of the body, which is, moreover, in the posterior segments completely divided up into a series of compartments, one to each segment, and whose lumen is also here and more anteriorly divided by delicate septa jutting into its cavity. Furthermore, by the fact that these tubes are not connected in successive segments by transverse vessels, as is so nearly universally the case.

(4) As a remarkable structural feature, which is at present mysterious in nature, may be mentioned the isolated cavities in the medullary region of the head which have no connection with the water vascular tubes.

(5) An anatomical feature of some importance is the very variable relation to each other in position of the extremities of the male and female ducts, which is correlated with an orifice upon one side of the body only. An alternation in the position of the external pore may, we know, be accompanied with difference in the relative position of the ducts as, for example, in the double series of genital tubes of *Moniezia*.

(6) In view of the very considerable peculiarities of structure briefly indicated in the foregoing résumé, it may be worth mentioning, as a remarkable fact, that the generative organs do not show any marked features of interest as compared with those of other tapeworms.

39. Studies in the Fossorial Wasps of the Family Scoliidæ, Subfamilies Elidinae and Anthoboscinae. By ROWLAND E. TURNER, F.Z.S., F.E.S.

[Received March 29, 1912: Read May 7, 1912.]

(Plates LXXXI.-LXXXIII.\*)

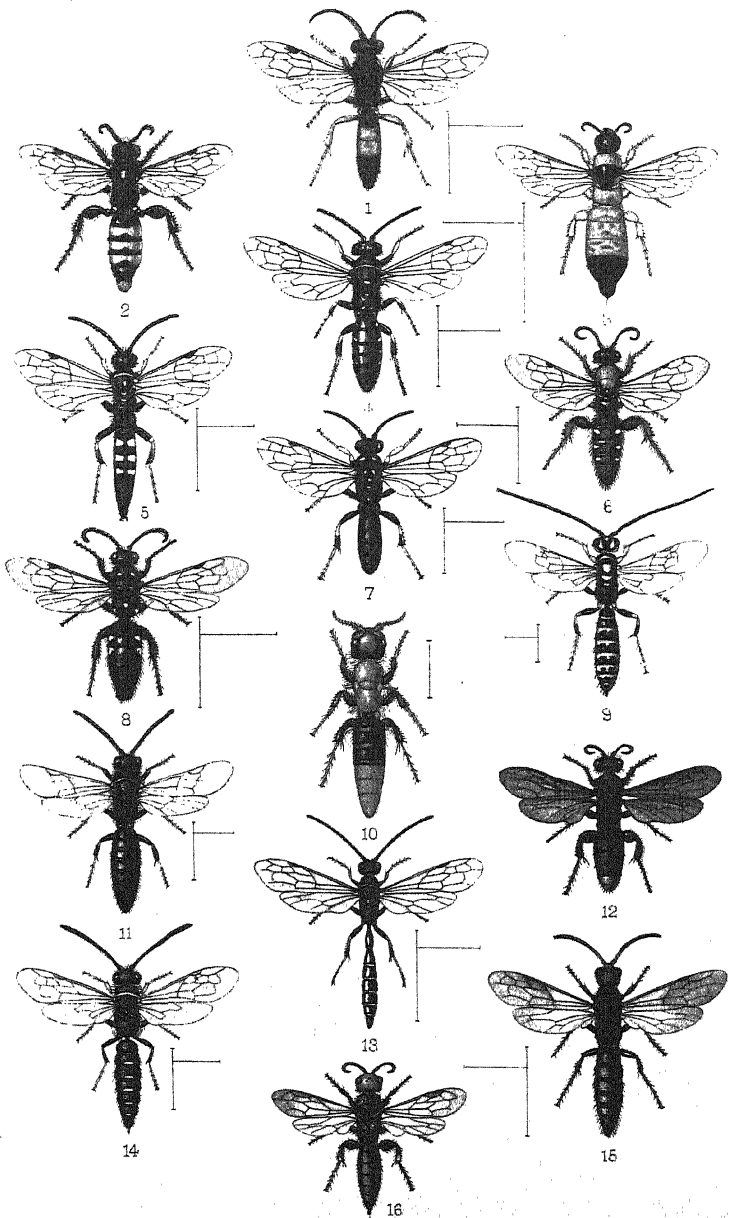
INDEX.		Page
Geographical Zoology:		
<i>Anthobosca</i> , Distribution of .....		726
Systematic:		
<i>Anthobosca occipitalis</i> sp. n. ....		731
<i>Braunsomeria</i> , gen. n. ....		697
" <i>quadratriceps</i> , sp. n. ....		698
" <i>atriceps</i> , sp. n. ....		699
<i>Ellis major</i> , sp. n. ....		723
" <i>sellowi</i> , sp. n. ....		722
" ( <i>Mesa</i> ) <i>aliciae</i> , sp. n. ....		704
" " <i>apicipennis</i> , sp. n. ....		707
" " <i>auriflua</i> , sp. n. ....		705
" " <i>incerta</i> , sp. n. ....		710
" " <i>longiventris</i> , sp. n. ....		712
" " <i>spoliata</i> , sp. n. ....		711
<i>Myzine braunsi</i> , sp. n. ....		700
" <i>combusta</i> Sm. to <i>Ellis</i> .....		724
" <i>constrictiventris</i> , sp. n. ....		701
" <i>sauakinensis</i> Grib. to <i>Anthobosca</i> .....		740
" <i>stigma</i> , sp. n. ....		699
" <i>umbratica</i> , sp. n. ....		702
<i>Odontothynnus</i> Cam. ♂ to <i>Anthobosca</i> .....		724
<i>Plesia continua</i> Cam. ♂ of <i>Myzina abdominalis</i> Guér.		703
" <i>erythronota</i> Cam. to <i>Anthobosca</i> .....		738
" <i>leucospila</i> Cam. " " .....		739
" <i>melanaria</i> Cam. " " .....		736

The following notes on the Elidinae and Anthoboscinae will, it is hoped, facilitate the study of these neglected groups, the latter of which especially has been very little understood by many authors, who have touched on it merely as describers of new species, Saussure alone having seriously studied the group. The best work on the Elidinae has been done by the same author, but the material at his disposal was very limited.

I am indebted to Dr. Brauns, of Willowmore, S. Africa, for valuable assistance with many carefully collected specimens. The material available is still insufficient for a revision of the species of *Myzine*, as to which much confusion still exists.

The species which I have not seen are marked with an asterisk.

\* For explanation of the Plates see pp. 753-754.

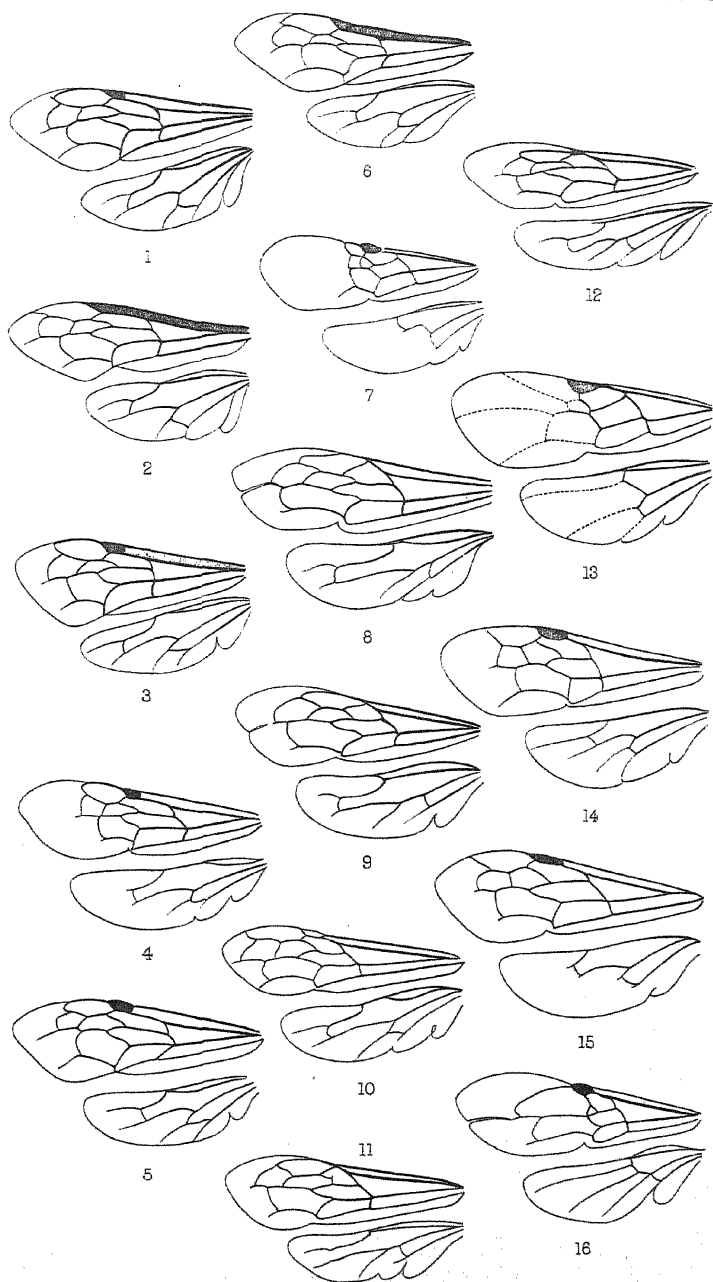


Horace Knight del. et lith

West, Newman chr.

FOSSORIAL WASPS.





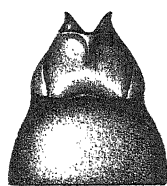
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West, Newman lith.

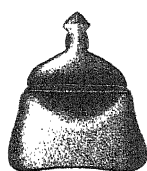
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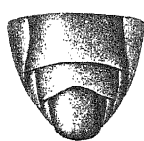




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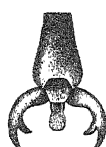
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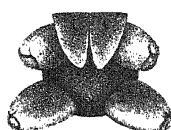
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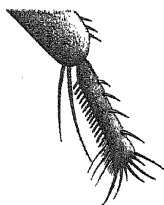
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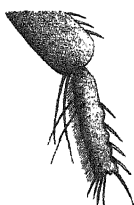
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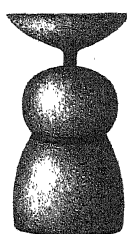
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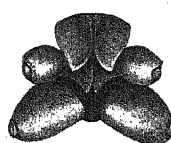
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Catherine A.M.Pearce del.

West, Newman lith.

EXOSKELETAL STRUCTURES OF FOSSORIAL WASPS.



## Family SCOLIIDÆ.

## Subfamily ELIDINÆ.

## BRAUNSONERIA, gen. nov.

♀. Apterous; mandibles acute at the apex, with a rather indistinct tooth on the inner margin near the apex; antennæ twelve-jointed, the first joint of the flagellum very small and almost concealed by the apex of the scape. Head almost rectangular, the posterior angles slightly rounded; eyes oval, touching the base of the mandibles, rather small, separated by a distance at least as great as their own length from the posterior angles of the head; ocelli absent, their position indicated by large punctures. Thorax much narrower than the head; pronotum rather longer than its greatest breadth; mesonotum very short, almost covered by the pronotum, the tegulæ more or less developed; scutellum narrower than the pronotum, broader than long; median segment nearly as long as the pronotum, flattened on the dorsal surface, broadened from the base to the apex. Sides of the head and thorax and base of the abdomen thinly covered with long hairs. Abdomen longer than the head and thorax combined, shining, the apical segment long and more or less acute at the apex, stricture between the first and second ventral segments well developed. Intermediate coxæ rather widely separated, posterior coxæ contiguous, intermediate and posterior tibiæ spinose, tarsal ungues simple.

♂. Winged; stigma rather large, situated at about three-fifths from the base of the wing; radial cell shorter than the stigma; three cubital cells, the second and third small, not reaching the apex of the radial cell, each receiving a recurrent nervure; cubital and discoidal nervures not continued beyond the cells. Median cell of the hind wing not emitting veins from the apex. Antennæ in the typical species long and slender, thirteen-jointed, the first joint of the flagellum almost concealed in the apex of the scape, the antennæ much longer than the abdomen; antennal tubercles well developed. Head strongly convex; ocelli present. First abdominal segment with a short petiole, the segment, including the petiole, a little longer than the second segment, suddenly widened at the apex of the petiole. Apical segment with a recurved spine, the apical emargination of the dorsal segment shallow. Eyes entire, not emarginate.

The characters given here for the male will doubtless be found not to apply to all species of the genus; but the important characters in the venation separating the males from *Myzine* are the larger stigma, the blunter apex of the radial cell, the fact that the cubital and discoidal nervures are not continued beyond the cells as in *Myzine*, and that no veins are emitted from the median cell of the hind wing, there being two veins in *Myzine*.

Type of the genus, *Braunsomeria quadriceps*.

BRAUNSONERIA QUADRATICEPS, sp. n. (Pl. LXXXI. figs. 9, 10; Pl. LXXXII. fig. 7.)

♀. *Rufo-ferruginea; mandibulis apice, vertice, capite lateribus; segmentis abdominalibus tribus basalibus nigris; femoribus tibiisque juncis, calcaris albidis.*

*Long. 8 mm.*

♀. Head broader than long, fully half as broad again as the pronotum; mandibles with a blunt tooth on the inner margin near the apex, another near the middle of the inner margin, acute, and another smaller nearer the base. The whole insect shining, with a few scattered punctures. Pronotum longer than broad, a little longer than the median segment. Dorsal abdominal segments broadly depressed at the apex, the basal portion of the segments produced into a slightly raised rounded mark on each side; apical segment very narrowly rounded at the extremity.

♂. *Niger; mandibulis, clypeo macula mediana nigra, scapo subtus apice, tuberculis antennalibus, macula parva frontali, margine interiore oculorum, linea undulata verticali, pronoto macula utrinque antice et fascia lata postice, mesonoto macula quadrata, scutello fascia lata, postscutello, mesopleuris fascia, segmento dorsali primo fascia apicali, ceteris fascia apicali macula nigra utrinque, segmentisque ventralibus 2-6 fascia bisinuata apicali pallide flavis; alis hyalinis, venis testaceis.*

*Long. 6 mm.*

♂. Antennæ slender, longer than the abdomen, the inter-antennal tubercles prominent. Clypeus very short and broad, very shallowly emarginate at the apex. Head very strongly convex, cheeks as broad as the eyes. Head and thorax coarsely but not very closely punctured, median segment finely and closely punctured-rugulose; abdomen shining, very sparsely and shallowly punctured. Pronotum shorter than the mesonotum, narrowed anteriorly, the anterior margin straight, posterior margin very feebly arched. Median segment steeply sloped posteriorly, not truncate. Petiole of the basal abdominal segment occupying less than half the length of the segment, the remainder of the segment slightly inflated; the first segment, including the petiole, only a little longer than the second. The segments not constricted; hypopygium forming a long recurved spine; apical dorsal segment convex, shallowly emarginate at the apex. Stigma large, twice as long on the costa as broad, nearly twice as long as the radial cell, which is broadly rounded at the apex. Three cubital cells on the right side, two on the left; on the right the second abscissa of the radius is very short, the third about equal to the first and second combined, but shorter than the second transverse cubital nervure, second recurrent nervure received close to the apex of the third cubital cell.

*Hab.* Willowmore, Cape Colony; January (*Dr. Brauns*).

The female is the type.

I have little doubt that links will be discovered connecting both sexes of this genus with *Myzine* through the short-winged *Pseudomeria* section in the females, and through species with somewhat more extended neuration in the males. But the apterous condition of the female and the differences of neuration pointed out in the description of the male seem to me to be sufficient reason for founding a new genus. The female shows a strong resemblance to female Thynnidae of the genus *Eirone*, also to the Bethyloid genus *Apenesia*. I have not been able to examine the mouth-parts, but it is likely that they would show atrophy of some parts. The entire eyes of the male are also noticeable as contrasted with the shallowly emarginate eyes of *Myzine*.

*BRAUNSOMERIA ATRICEPS*, sp. n.

♀. *Nigra; mandibulis basi, clypeo, antennis, thorace, segmento mediano, pedibus pygidioque apice ferrugineis.*

*Long. 5 mm.*

♀. Mandibles acute, with a very small ill-defined tooth on the inner margin near the apex. Head rectangular, a little broader than long, very slightly convex, shining, with a few scattered punctures. Thorax shining, with a few scattered punctures on the pronotum, the median segment more closely punctured. Pronotum longer than broad, slightly narrowed anteriorly, narrower than the head by about one-third; mesonotum very short, the tegulae rather better defined than in *quadraticeps*; scutellum rounded posteriorly, broader than long. Median segment a little shorter than the pronotum, slightly broadened from the base, a little broader than long and obliquely sloped posteriorly; sides of the thorax and median segment sparsely clothed with long yellowish hairs. Abdomen shining, finely aciculate, the basal segment truncate anteriorly, with a short petiole not more than half as long as the posterior coxae; the third segment the broadest; a semicircular small raised mark on each side of dorsal segments 2-5; sixth segment smooth, pointed at the apex. The constriction between the two basal ventral segments is well marked. The eyes are smaller than in *quadraticeps* and are separated from the posterior angle of the head by a distance equal to about three times their own length.

*Hab.* Algoa Bay, Cape Colony; November (*Dr. Brauns*).

*MYZINE (?) STIGMA*, sp. n. (Pl. LXXXI. fig. 11; Pl. LXXXII. fig. 13.)

♂. *Niger; mandibulis basi, pronoto anguste postice, tegulis, tibiis subtus tarsisque basi pallide flavis; alis hyalinis, venis perlucidis, stigmatibus maximo, pallide flavescens; oculis haud emarginatis, antennis abdomine brevioribus; cellula radiali oblitterata, cellula cubitali secunda pene oblitterata.*

*Long. 7 mm.*

♂. Clypeus very short, transverse. Antennae about as long as

the thorax and median segment combined, not very slender; of about even thickness throughout, inserted a little nearer to the eyes than to each other. Eyes not emarginate, their inner margins parallel; posterior ocelli a little nearer to each other than to the eyes. Head convex, closely punctured, with a frontal sulcus reaching to the ocellus; antennal tubercles not developed. Thorax rather sparsely punctured. Pronotum rather short, as broad as the head, the anterior margin straight, the posterior margin widely and feebly arched. Scutellum large, a little shorter than the mesonotum. Median segment short, almost smooth, with a median sulcus, truncate posteriorly. Abdomen subsessile, the basal segment broad, not constricted at the apex on the dorsal surface, deeply divided from the second on the ventral surface, all the segments sparsely punctured and shining; the apical segment rather deeply triangularly incised for the reception of the long aculeus of the hypopygium; the whole abdomen about equal in length to the head, thorax, and median segment combined. Stigma very large, about twice as long as the greatest breadth; only one cubital cell and one recurrent nervure, which is received on the cubitus just beyond the angle of the cubital cell, the cubitus continued just beyond the point of reception of the recurrent nervure, the radial cell and all neuration beyond the stigma obliterated. Median and submedian cells of the hind wing present, but no neuration beyond them, the median cell not extending very far beyond the submedian.

*Hab.* Willowmore, Cape Colony (*Dr. Brauns*).

This very distinct species will probably prove to be generically distinct from *Myzine*. It approaches most nearly to *M. swalei* Turn. and *M. braunsi* Turn., but differs in the reduced neuration, the entire eyes, the more robust and subsessile abdomen, and the much broader stigma. But until the female is known I prefer to leave it provisionally in *Myzine*. From *Braunsomeria*, to which the neuration approaches more nearly than to *Myzine*, it may be distinguished by the much more robust build, the much shorter and stouter antennæ, and the deeper emargination of the apical segment.

*MYZINE BRAUNSI*, sp. n. (Pl. LXXXI. fig. 14; Pl. LXXXII. fig. 14.)

♂. *Niger*; *mandibulis basi, pronoto fascia angusta postice, segmentis dorsalibus 2-6 macula transversa mediali apice, maculaque curvata laterali utrinque, tegulis, tarsis articulo apicali excepto, tibiis anterioribus omnino, intermediis posterioribusque basi pallide flavis; alis hyalinis, venis perlucidis, stigmatibus pallide testaceo.*

*Variat segmentis dorsalibus macula mediali obliterated.*

*Long.* 5-8 mm.

♂. Clypeus much broader than long, closely punctured and shallowly emarginate at the apex. Antennæ gradually thickened

towards the apex, the terminal joint twice as thick as the fourth; the antennæ about as long as the head, thorax, and median segment combined. Eyes slightly emarginate on the inner margin; posterior ocelli nearly as far from each other as from the eyes. Head and thorax closely and not very finely punctured; pronotum narrower than the head, shorter than the mesonotum, narrowed anteriorly, the anterior margin straight, the posterior margin widely but not strongly arched. Median segment transversely rugose, with a longitudinal depression in the middle, truncate posteriorly, the surface of the truncation coarsely transversely striated. Abdomen narrower than the thorax and nearly half as long again as the head, thorax, and median segment combined, finely and sparsely punctured, the segments scarcely constricted at the base; petiole of the basal segment very short, the segment abruptly broadened and slightly swollen, nearly as long as the second segment without including the petiole. Apical segment convex, the incision at the apex subtriangular, not quite as deep as its apical breadth. Tarsal unguis simple. Cubital and discoidal nervures not continued beyond the cells, stigma not rounded on the inner margin, three times as long as the greatest breadth; radial cell acute at the apex, produced far beyond the third cubital cell, second and third abscissæ of the radius nearly equal in length, second recurrent nervure received just before the middle of the third cubital cell. Median cell of the hind wing not emitting any veins from the apex.

*Hab.* Willowmore, Cape Colony; January to March (*Dr. Brauns*).

This is allied to *M. swalei* Turn., but differs in the shorter and stouter basal abdominal segment, in the sculpture of the median segment, and in the translucent nervures of the wings. Both differ from typical *Myzine* by not having the cubital and discoidal nervures continued beyond the cells and in the absence of the two veins emitted from the apex of the median cell of the hind wings.

MYZINE CONSTRICTIVENTRIS, sp. n. (Pl. LXXXII. fig. 15; Pl. LXXXIII. fig. 12.)

♂. *Niger, dense albo-pilosus; mandibulis basi, pronoto margine posteriore, tegulis basi, segmentis dorsalibus 2-6 macula mediana apiculi et macula transversa utrinque, tibiis basi tarsisque pallide flavis; alis hyalinis, venis brunneis.*

*Long.* 10-12 mm.

♂. Clypeus broad and short, shallowly emarginate at the apex. Eyes distinctly convergent towards the clypeus, the inner margin not emarginate, almost straight. Antennæ inserted nearer to each other than to the eyes, almost as long as the abdomen, moderately stout and of almost even thickness throughout. Posterior ocelli a little nearer to the eyes than to each other. Head and thorax closely and strongly punctured; pronotum short, narrower than the head, the anterior margin straight, the posterior margin very feebly arched. Median segment coarsely

rugose, almost vertically truncate posteriorly. Abdomen much longer than the head and thorax combined, not very slender, sparsely punctured, the segments rather strongly constricted at the base, subsessile, the first segment no longer than the second. Sixth dorsal segment more coarsely punctured, not convex, the lateral margins raised, the apical emargination shallow, much broader at the apex than deep. Radial cell broad, nearly twice as long on the costa as the greatest breadth; second abscissa of the radius distinctly longer than the third, second recurrent nervure received close to the middle of the third cubital cell.

*Hab.* Willowmore, Cape Colony; October to January (*Dr. Brauns*).

This species is easily distinguished by the absence of any emargination of the eyes, the shallow emargination of the apical dorsal segment, the strongly constricted abdominal segments, and the broad radial cell. The cubital and discoidal nervures are continued very little beyond the cells, and the two nervures emitted from the apex of the median cell of the hind wing are very short.

*MYZINE UMBRATICA*, sp. n.

♀. *Nigra, mandibulis pygidioque fusco-ferrugineis; segmentis dorsilibus 2-3 macula laterali utrinque alba; alis fusco-violaceis.*

*Long.* 10 mm.

♀. Shining and almost smooth, coarsely but not very closely punctured round the base of the antennæ; a few scattered punctures on the vertex, pronotum, mesonotum, and scutellum, pro- and mesopleuræ strongly but not very closely punctured; median segment closely and rather finely punctured at the base, almost smooth in the middle and at the apex, a few obscure striae at the posterior angles; abdomen almost smooth, with a few small punctures on the apical portion of the segments. Long black pubescence on the sides of the thorax; calcaria whitish. Eyes rather narrowly ovate, cheeks as broad as the eyes; ocelli small, the posterior pair about as far from each other as from the eyes. Antennæ smooth and shining, the scape beneath punctured and clothed with long hairs. Head subrectangular, half as broad again as long, much broader than the thorax. Pronotum about twice as broad as long, the posterior margin almost straight. Mesonotum only half as long as the pronotum and a little shorter than the scutellum, the parapsidal furrows very distinct. Apical segment of the abdomen convex, long, and pointed. Wings of moderate length, reaching to the fifth abdominal segment, the stigma situated about halfway between the base and apex; venuration similar to that of *rufifrons* Fabr.

*Hab.* Fourteen Streams, Cape Colony; January (*Dr. Brauns*).

There is only a very obscure median sulcus on the median segment. The slit in the fore wing extends from the termination of the cubitus just beyond the third cubital cell to the margin of the wing.



MYZINE ABDOMINALIS Guér. (Pl. LXXXII. fig. 16;  
Pl. LXXXIII. fig. 5.)

*Meria abdominalis* Guér. Rev. de Zool. iii. p. 365 (1839), ♀.

*Plesia continua* Cam. Rec. Albany Mus. i. p. 299 (1905), ♂.

*Hab.* Willowmore; Burghersdorp, Cape Colony.

Taken in copulâ by Dr. Brauns. The colour in the female is variable, the head being sometimes ferruginous.

*Key to the Ethiopian Species of Elis (Mesa).*

*Females.*

- |  |     |                               |
|--|-----|-------------------------------|
| 1. Basal joint of posterior tarsi with a row of spines beneath .....   | 2.  |                               |
| Basal joint of posterior tarsi unarmed or with a scopa only beneath .....  | 7.  |                               |
| 2. Radial cell distinctly separated from the costa for more than half the length. Black, two apical abdominal segments red .....                               |     | <i>E. alicie</i> Turn.        |
| Radial cell separated from the costa at the apex only .....  | 3.  |                               |
| 3. Abdomen ferruginous, the basal segment only black. Abdomen black .....  |     | * <i>E. abdominalis</i> Guér. |
| 4. Thorax and abdomen entirely black .....   | 4.  |                               |
| Thorax more or less red, the pronotum shorter than the scutellum .....   | 5.  |                               |
| 5. Sixth dorsal segment punctured; calcaria of the hind tibiae black .....   | 6.  |                               |
| Sixth dorsal segment striate; calcaria whitish .....   |     | * <i>E. peringueyi</i> Sauss. |
| 6. Vertex red, much more sparsely punctured than the front, mesonotum and scutellum black. Spur of the posterior tibiae not strongly bent near the base .....  |     | * <i>E. hottentota</i> Sauss. |
| Vertex black, as closely punctured as the front, mesonotum and scutellum red. Spur of the posterior tibiae strongly bent near the base .....                   |     | <i>E. adelogamia</i> Turn.    |
| 7. Abdomen wholly bright ferruginous .....   |     | <i>E. auriflua</i> Turn.      |
| Abdomen black, the two apical segments sometimes ferruginous red .....   |     | <i>E. torrida</i> Sm.         |
| 8. Lateral margins of the median segment acute; head, thorax, legs, and abdomen black .....  | 8.  |                               |
| Lateral margins of the median segment not acute .....  | 9.  |                               |
| 9. Median segment twice as broad as the length in the middle, the lateral carinae sharply defined. Antennae fusco-ferruginous at the base, black at apex ..... | 10. |                               |
| Median segment about three times as broad as the length in the middle, the lateral carinae not sharply defined. Antennae wholly orange .....                   |     | <i>E. satasurei</i> Turn.     |
| 10. Head, thorax, and abdomen black .....  |     | <i>E. xanthocera</i> Gerst.   |
| Head, thorax, and abdomen more or less red .....   | 11. |                               |
| 11. Legs black. Punctures of front and pronotum coarse and confluent longitudinally .....  | 12. |                               |
| Legs ferruginous. Punctures of front and pronotum not coarse and well separated .....  |     | <i>E. innotata</i> Turn.      |
| 12. Apical or two apical segments of abdomen ferruginous red, head and thorax black .....  |     | <i>E. erythropoda</i> Turn.   |
| Abdomen wholly black, head and sometimes thorax more or less red .....   | 13. |                               |
| 13. Two apical segments of the abdomen red; fore wings fuscous except at the apex; sixth dorsal segment punctured .....  | 14. |                               |
| Apical segment of abdomen only red; wings hyaline; sixth dorsal segment striate .....  |     | <i>E. apicipennis</i> Turn.   |
|  |     | <i>E. pyxidata</i> Turn.      |

- |  |  |
|--|--|
| 14. Wings subhyaline; head, pronotum, mesonotum, and scutellum red; vertex punctured ..... | <i>E. heterogamia</i> Sauss.           |
| Wings fusco-violaceous .....   | 15.                                    |
| 15. Vertex punctured; pronotum closely punctured; legs black .....                         | <i>E. nova</i> Turn.                   |
| Vertex smooth; pronotum sparsely punctured; legs red .....                                 | 16.                                    |
| 16. Head red, thorax black .....   | <i>E. ruficeps ruficeps</i> Sm.        |
| Thorax more or less red .....  | <i>E. ruficeps atopogamia</i> [Sauss.] |

### Males.

- |  |                              |
|--|------------------------------|
| 1. Apical dorsal segment not incised at the apex .....   | 2.                           |
| Apical dorsal segment more or less incised at the apex .....   | 4.                           |
| 2. Third dorsal segment of the abdomen measured from the transverse basal furrow distinctly shorter than its basal width. Abdomen wholly without yellow markings ..... | <i>E. incerta</i> Turn.      |
| Third dorsal segment measured from the transverse basal furrow distinctly longer than its basal width. Abdomen with very small yellow markings .....                   | 3.                           |
| 3. Apical dorsal segment flattened, with raised margins and a median carina; pronotum entirely black ...   | <i>E. asharensis</i> Turn.   |
| Apical dorsal segment convex, the margins not raised, without a distinct median carina; pronotum with a yellow band on the posterior margin .....                      | <i>E. amethystina</i> Turn.  |
| 4. Abdomen entirely black, sometimes with blue sheen. Abdomen banded with yellow .....   | 5.                           |
| 5. Wings more or less shaded with fuscous or violaceous; incision of the apical segment half as deep as its apical width. Length 15-18 mm. ....                        | 6.                           |
| Wings clear hyaline; incision of apical segment much less than half as deep as its apical width. Length 13 mm. ....  | <i>E. ruficeps</i> Sm.       |
| 6. Apical dorsal segment flattened with raised margins; head large, the cheeks more than half as broad as the eyes .....   | <i>E. noliola</i> Guér.      |
| Apical dorsal segment convex, with a median carina; head small, the cheeks much less than half as broad as the eyes .....  | <i>E. capitata</i> Sm.       |
| 7. Not very slender; the apical dorsal segment with an incision nearly as deep as broad at the apex .....  | 7.                           |
| Very slender; incision of the apical dorsal segment not more than half as deep as its apical breadth ...   | <i>E. spoliata</i> Turn.     |
|  | <i>E. longiventris</i> Turn. |

ELIS (MESA) ALICIE, sp. n. (Pl. LXXXI. fig. 12; Pl. LXXXII. fig. 8; Pl. LXXXIII. fig. 9.)

♀. *Nigra*; *segmentis abdominalibus quinto sextoque rufo-ferrugineis*; *pedibus albo-pilosus, calcariis albidis*; *alis nigro-ceruleis*.

Long. 18 mm.

♀. Head and thorax coarsely punctured-rugose, the punctures on the front finer than on the vertex; clypeus very broadly rounded at the apex, with two or three indistinct teeth on the margin; scape shining and sparsely punctured, clothed beneath with long whitish hairs; the nine apical joints of the flagellum opaque. Front thinly clothed with white hairs, the interantennal prominence well developed and feebly bilobed. Inner margin of the eyes slightly sinuate; posterior ocelli about twice as far from

the eyes as from each other. Pronotum nearly as broad as the head, widely emarginate anteriorly; scutellum with a large triangular rugose area from the base to the narrowly truncated apex, the sides smooth and opaque. Postscutellum and median segment smooth and opaque, a few large punctures on the middle of the postscutellum; median segment raised towards the median line, with a narrow margined median groove, the posterior truncation of the segment coarsely but shallowly punctured, the sides of the segment closely obliquely striated. Abdomen shining, finely and very sparsely punctured, the punctures larger on the ventral than on the dorsal surface, and rather closer at the apex of the segments than at the base; the apical dorsal segment broadly rounded, and longitudinally punctured-striate. Second abscissa of the radius a little shorter than the third; first recurrent nervure received beyond the middle of the second cubital cell, second at two-thirds from the base of the third cubital cell. Radial cell detached from the costa for about half its length.

*Hab.* British East Africa, Makindu, 3300 ft. (*S. A. Neave*); April 5-7, 1911 (*A. E. R. C.*).

This fine species does not seem to be very nearly allied to any other, being well distinguished from the *ruficeps* group by the very coarse sculpture of the head and thorax. The basal joint of the posterior tarsi is furnished with a closely-set comb of small spines beneath.

The description of *Cosila donaldsoni* Fox corresponds rather closely to this species, but the clypeus is tridentate on the apical margin, not rounded, with indistinct teeth as in the present species, and I think Fox was too careful a worker to have confused the genera.

*ELIS (MESA) AURIFLUA*, sp. n.

♀. *Nigra; mandibulis basi, pronoto, mesonoto scutelloque rufoferrugineis; alis infuscatis.*

*Long.* 12 mm.

♀. Head and pronotum closely and rather strongly punctured; mesonotum and scutellum much more sparsely punctured, smooth in the middle; pleuræ coarsely punctured; median segment finely and closely punctured, the median groove narrow and shallow, margined by low carinæ, the posterior truncation more shallowly punctured. Abdomen rather closely and not very finely punctured, the apical segment closely longitudinally striated. Sides of the median segment obliquely striated. Clypeus transverse at the apex. Eyes very feebly and widely emarginate on the inner margin; posterior ocelli further from the eyes than from each other. Head more than half as broad again as long, broader than the thorax. Pronotum short, not as long in the middle as the scutellum, the anterior margin straight, the posterior margin widely arched. Pubescence sparse and whitish, calcaria whitish. Radial cell only separated from the costa at the apex, which is subtruncate; first abscissa of the radius as long as the second,

but shorter than the third; recurrent nervures received close to the middle of the second and third cubital cells.

*Hab.* Johannesburg, Transvaal (*Kobrow*). Received from Dr. Brauns.

Nearly allied to *adelogamia* Turn. and *diapherogamia* Sauss. From the former it may be distinguished by the entirely black head, and by the closer and more even puncturation of the head and pronotum, the vertex being almost smooth in *adelogamia*; from *diapherogamia* it may be distinguished by the much shorter pronotum, the stronger and closer puncturation, and the colour of the head. *E. hoca* has the pronotum longer than in the present species or *adelogamia*.

The comb on the underside of the basal joint of the posterior tarsi is present, but the teeth are few. The upper spur of the hind tibiae is strongly bent near the base.

ELIS (MESA) ADELOGAMIA Turn.

*Plesia (Mesa) adelogamia* Turn. Ann. & Mag. Nat. Hist. (8) i. p. 503 (1908), ♀.

*Hab.* Maseru, Basutoland; Lichtenburg, Transvaal.

This is nearly allied to *E. auriflua*, but differs as noticed in the key.

ELIS (MESA) RUFICEPS Sm. (Pl. LXXXII. figs. 9, 10; Pl. LXXXIII. figs. 2, 4, 10, 15, 16.)

*Myzine ruficeps* Sm. Cat. Hym. B. M. iii. p. 75 (1855), ♀; Turner, Ann. & Mag. Nat. Hist. (8) i. p. 503, ♂; Turner, Ann. & Mag. Nat. (8) vii. p. 304 (1911), ♂ ♀.

ELIS (MESA) RUFICEPS, subsp. ATOPOGAMIA Sauss.

*Plesia (Mesa) atopogamia* Sauss. in Grandidier, Hist. Madagascar, xx. p. 244 (1892), ♀.

*Plesia (Mesa) diapherogamia* Sauss.; Distant, Naturalist in the Transvaal, p. 225 (1892), ♀.

*Plesia (Mesa) disjuncta* Turn. Ann. & Mag. Nat. Hist. (8) i. p. 502 (1908), ♂.

*Elis (Mesa) ruficeps*, subsp. *atopogamia* and *diapherogamia* Turn. Ann. & Mag. Nat. Hist. (8) vii. p. 304 (1911), ♂ ♀.

*Hab.* Zanzibar; Nyasaland; Transvaal.

The colour-differences between *atopogamia* and *diapherogamia* are not constant, though in the former the mesonotum is usually red and in the latter black. The wings of the male are darker in specimens from Nyasaland than in those from the Transvaal. A single male received from Harar, in S. Abyssinia, has the wings entirely hyaline, slightly iridescent.

ELIS (MESA) HETEROGAMIA Sauss.

*Plesia (Mesa) heterogamia* Sauss. in Grandidier, Hist. Madagascar, xx. p. 244 (1892), ♀.

*Hab.* Delagoa Bay; Manica; South Nyasaland.

ELIS (MESA) HOVA Turn.

*Plesia (Mesa) hova* Turn. Ann. & Mag. Nat. Hist. (8) i. p. 504 (1908), ♀.

*Hab.* Madagascar.

Probably the female of *nodosa* Guér.

\*ELIS (MESA) ABDOMINALIS Guér.

*Plesia abdominalis* Guér. Rev. Zool. i. p. 57 (1838), ♀.

*Plesia (Mesa) abdominalis* Sauss. in Grandidier, Hist. Madagascar, xx. p. 244 (1892), ♀.

*Hab.* South Africa.

ELIS (MESA) APICIPENNIS, sp. n.

♀. *Nigra*; *segmentis abdominalibus quarto apice, quinto sextoque rufo-ferrugineis*; *mandibulis basi antennisque ferrugineis, calcariis albidis*; *alis fuscis, apice anguste hyalinis*.

*Long.* 10 mm.

♀. Clypeus finely punctured, broadly rounded at the apex. Head sparsely and rather finely punctured, shining, almost smooth round the anterior ocellus; interantennal prominence bilobed, divided by a longitudinal sulcus which does not reach the anterior ocellus. Scape shining, very sparsely punctured; flagellum opaque, the two basal joints shining. Posterior ocelli nearly as far from each other as from the eyes. Pronotum and pleuræ closely but not coarsely punctured; mesonotum and scutellum more sparsely punctured; median segment opaque, finely punctured, the punctures more or less confluent longitudinally, the median groove shallow and not distinctly margined. Abdomen shining, finely and rather closely punctured, with a very short petiole, the first segment broadly truncate at the base; the sixth dorsal segment punctured, rounded at the apex. The sides of the median segment are closely obliquely striated. Third abscissa of the radius at least half as long again as the second; first recurrent nervure received just beyond the middle of the second cubital cell, second at two-thirds from the base of the third cubital cell. Radial cell not distinctly separated from the costa, narrowly rounded at the apex.

*Hab.* British East Africa, Makindu, 3300 ft. (*S. A. Neave*); April 5-7, 1911 (*A. E. R. C.*).

Nearly allied to *E. pygidata* Turn. from N.E. Rhodesia, but differs in the broader shape of the third cubital cell, the position of the second recurrent nervure, the colour of the scape, of the wings, and of the fourth and fifth abdominal segments, in the finer and sparser puncturation and in the sculpture of the pygidium. The wings are clear hyaline beyond the radial and cubital cells. Basal joint of the posterior tarsi with a scopa of white hairs beneath; spur of the posterior tibiae bent near the base.

## ELIS (MESA) TORRIDA Sm.

*Myzine torrida* Sm. Desc. new spec. Hymen. p. 178 (1879), ♀.

♀. *Nigra*; *mandibulis basi, scapo apice abdomineque toto ferrugineis; tegulis testaceis; tibiis tarsisque fusco-ferrugineis; alis hyalinis, venis nigris.*

*Long.* 12 mm.

♀. Clypeus short, transverse at the apex, subcarinate in the middle, finely punctured at the base, smooth at the apex. Front, pronotum, and mesopleurae closely and strongly punctured, vertex a little more sparsely punctured; mesonotum and scutellum coarsely but sparsely punctured; pronotum as long as the scutellum. Median segment twice as broad as the length in the middle, not margined, almost smooth, but not shining; the median groove narrow but well defined, with the margins of the groove raised. Abdomen shining, with a few scattered punctures, the apical dorsal segment finely longitudinally striated. Basal joint of the posterior tarsi unarmed beneath, with a scopula of very fine hairs. Radial cell detached from the costa at the apex, third abscissa of the radius longer than the second, but a little shorter than the first, second recurrent nervure received just beyond two-thirds from the base of the third cubital cell.

*Hab.* Gambia (*ex coll. Shuckard*).

## \*ELIS (MESA) PERINGUEYI Sauss.

*Plesia (Mesa) peringueyi* Sauss. in Grandidier, Hist. Madagascar, xx. p. 245 (1892), ♀.

"Areola radialis apice minute truncata. Secunda v. recurr. in ipso medio margine tertiæ ar. cubitalis exserta. Metatarsus posticus subtus scopula spinarum brevium instructus. Majuscula, nigra, nitida, cinereo-lirata. Caput et thorax cribrosa. Caput validum, quam pronoto paulo latius. Metathorax leviusculus, superne tenuiter punctatus, subtiliter carinatus (carina a latere visa subbituberculata) utrinque pago polito; ejus facies postica plana, subrugulata; metapleura strigata. Epipygium elongato-trigonale, punctatum. Spinæ tib. post. nigrae, acutæ. Metatarsus posticus subtus pectinatus, pilis vel spinis albidis intermixtis, spinisque nonnullis dilatatis. Alæ bruneo-nebulosa, venis fuscis; 2<sup>a</sup> ar. cubit. intus valde acuta; 2<sup>a</sup> vena recurrens transversalis, cum v. discoidali angulum fere rectum efficiens."

## \*ELIS (MESA) HOTTENTOTA Sauss.

*Plesia (Mesa) hottentota* Sauss. in Grandidier, Hist. Madagascar, xx. p. 245 (1892), ♀.

"Areola radialis apice minute truncata. Secunda v. recurr. in ipso medio margine tertiæ ar. cubitalis exserta. Metatarsus posticus subtus scopula spinarum brevium instructus. Minor, nigra, cinereo-lirata. Antennæ imo apice flavo. Caput et thorax sat tenuiter cribrosa. Caput quam thorax vix latius. Metathorax leviusculus, subtilissime punctato-rugulatus, superne

obsolete roundato-carinatus; facie postica punctulata, supra distincte angulata, obtusangula, fere rectangula. Epipygium trigonale, striolatum, margine lævi. Spinæ tib. post. albescentes, squamosæ. Alæ subhyalinæ venis bruneis et fuscis; parte apicali nebulosa, 2<sup>a</sup> ar. cubit. intus breviter acute producta; 2<sup>a</sup> vena recurrens arcuata, obliqua. In alis posticis v. discoidalis longius ultra venulam transverso-discoidalem furcata. Long 14 mill.; al. 10 mill. (Africa meridionalis)."

\**ELIS (MESA) CAPENSIS* Lep.

*Tiphia capensis* Lep. in Hist. Nat. Insect., Hym. iii. p. 554 (1845), ♀.

"Caput nigrum, supra nigro, subtus rufo subvillosum. Antennæ nigrae, articulo primo nigro hirtio. Thorax niger rufo subhirtus. Abdomen nigrum, subnudum. Pedes nigri, rufopallido subvillosi, femoribus duobus posticis angulatis compressisque. Alæ rufo-fuscae, nervuris costaque rufo-fuscis; squama nigra, Cellula radialis clausa. Femina."

"Long. 7 lignes.

"Cap de Bonne Espérance. Musée de M. Serville."

The figure shows that this species is an *Elis*.

*ELIS (MESA) INNOTATA* Turn.

*Plesia (Mesa) innotata* Turn. Ann. & Mag. Nat. Hist. (8) i. p. 506 (1908), ♀.

*Hab.* Loangwa River, N.E. Rhodesia; S. Nyasaland,

*ELIS (MESA) SAUSSUREI* Turn.

*Plesia (Mesa) saussurei* Turn. Trans. Ent. Soc. London, 1910, p. 394, ♀.

*Hab.* Madagascar.

This is near *E. xanthocera*, but the median segment is longer in proportion and much more distinctly margined; the colour of the antennæ is also different.

*ELIS (MESA) XANTHOCERA* Gerst.

*Myzine xanthocera* Gerst. Arch. f. Naturg. xxxvii. p. 353 (1870), ♀; v. d. Decken, Reise in Ost-Afrika, Gliedethiere, p. 339, pl. 14, fig. 5 (1873), ♀.

*Plesia (Mesa) xanthocera* Sauss. in Grandidier, Hist. Madagascar, xx. p. 245 (1892), ♀.

*Hab.* Howick, Natal; Zoutpansberg, Transvaal; Mozambique; Harar, Abyssinia.

*ELIS (MESA) ERYTHROPODA* Turn.

*Plesia (Mesa) erythropoda* Turn. Ann. & Mag. Nat. Hist. (8) i. p. 505 (1908), ♀.

*Hab.* Lake Ngami.

The scopa beneath the basal joint of the hind tarsus is rather

coarse at the base, but I do not think that any spines are present.

ELIS (MESA) INCERTA, sp. n.

♂. *Niger, cano-pilosus; clypeo macula mediana minuta, tibiis anticis supra pallide flavis; tegulis pedibusque fuscis; alis hyalinis, venis nigris; pygidio haud inciso.*

*Long.* 13 mm.

♂. Front coarsely reticulated, the vertex punctured; thorax closely but not coarsely punctured, median segment punctured-rugose, abdomen finely and closely punctured. Pronotum shorter than the scutellum, the anterior margins straight, the angles subacute. First abdominal segment petiolate, the narrow petiole scarcely more than half as long as the dilated apical portion of the segment, which is constricted at the apex; second segment twice as broad at the apex as at the base, all the segments slightly constricted at the base. Apical dorsal segment sparsely punctured, without an incision, somewhat convex, subcarinate in the middle, pointed at the apex, the lateral margins raised near the apex. Third abscissa of the radius a little longer than the second, which is fully twice as long as the fourth. First transverse cubital nervure oblique, sharply bent close to the cubitus, second recurrent nervure received just before one-third from the base of the third cubital cell, curved outwards below the middle, the ends slightly curved inwards.

*Hab.* Howick, Natal (*J. P. Gregoe*); Cape Colony.

This is very near the description of *Plesia carbonaria* Cam., but in that species the seventh dorsal segment is said to be shortly incised at the apex, and the fourth abscissa of the radius is almost as long as the second or third.

ELIS (MESA) CAPITATA Sm.

*Myzine capitata* Sm. Cat. Hym. B. M. iii. p. 74 (1855), ♂.

♂. *Niger, albido-pilosus; clypeo, mandibulis, linea obliqua utrinque supra antennis, pronoto fascia angusta postice, tegulis basi, segmento dorsali primo fascia apicali emarginata, segmentis dorsalibus et ventralibus 2-6 fascia bisinuatâ angusta flavis; pedibus flavis nigro-variegatis; alis hyalinis, venis testaceis.*

*Long.* 14-17 mm.

♂. Head large, much broader than the thorax, the cheeks more than half as broad as the eyes; antennæ stout, the apical joint truncate at the apex. Head rugose, thorax closely punctured, median segment punctured-rugose; abdomen shining, glossed with blue, very finely and closely punctured. Pronotum shorter than the scutellum, slightly narrowed anteriorly, the anterior margin straight, the angles not prominent, posterior margin widely arched. First abdominal segment petiolate, the petiole only about half as long as the rather strongly swollen apical



portion, the apex slightly constricted. Apical dorsal segment flattened, subcarinate in the middle, the lateral margins raised and nearly parallel, the apical incision subtriangular, not quite as deep as the apical width. Second and third abscissæ of the radius nearly equal in length; second recurrent nervure strongly curved outwards below the middle, joining the cubitus just before one-fourth from the base of the third cubital cell.

*Hab.* Johannesburg, Transvaal; Kroonstad.

The type is much damaged and without wings; the details of neurulation are taken from a more recent specimen in which the cubitus of the hind wing on the right side is almost interstitial with the transverse median nervure, but is further removed towards the base on the left side.

ELIS (MESA) SPOLIATA, sp. n.

♂. *Niger*; *mandibulis, clypeo macula parva nigra utrinque, linea utrinque supra antennis, pronoto angulis anticis et fascia postice, tegulis, segmento dorsali primo fascia angusta apicali, segmentis dorsalibus et ventralibus 2-6 fascia bisinuata angusta, coxis apice, femoribus posticis supra, tibiis anticis et intermediis supra tarsisque subtus pallide flavis; pedibus rufo-testaceis; alis hyalinis, venis nigris, stigmate rufo-testaceo.*

*Long.* 13 mm.

♂. Clypeus short and broad, rather narrowly produced in the middle and very feebly emarginate at the apex. Eyes widely emarginate; cheeks very much narrower than the eyes; posterior ocelli more than half as far again from the eyes as from each other. Antennal tubercles well developed; antennæ longer than the head, thorax, and median segment combined, of even thickness throughout. Head punctured-rugose, much wider than the thorax; the whole thorax finely and closely punctured, with sparse white pubescence; pronotum a little longer in the middle than the scutellum, narrowed anteriorly, the anterior margin straight, posterior margin strongly arched. Median segment rounded posteriorly, not truncate, very closely but not coarsely punctured. Abdomen slender, slightly shining, very finely and sparsely punctured, petiolate; the petiole occupying the basal third of the first segment, the apical two-thirds elongate pyriform, the whole segment half as long again as the second, which is gradually broadened from the base, a little longer than the apical width; third segment broader than long. Apical dorsal segment slightly convex, subcarinate longitudinally in the middle, shining, with a few large punctures, the apical emargination almost as deep as its breadth at the apex. Radial cell pointed; second abscissa of the radius shorter than the third, but much longer than the first; second recurrent nervure received at one-third from the base of the third cubital cell.

*Hab.* Algoa Bay, Cape Colony; March (*Dr. Brauns*).

Nearly allied to *E. capitata* Sm., but in that species the head

is larger, the cheeks much broader, and the first abdominal segment a little shorter and more swollen towards the apex. The apical dorsal segment in *capitata* is flat, not convex, and has the sides distinctly raised into marginal carinae.

ELIS (MESA) LONGIVENTRIS, sp. n. (Pl. LXXXI. fig. 13; Pl. LXXXIII. fig. 11.)

♂. *Niger*; *mandibulis, clypeo, linea obliqua utrinque supra antennis, pronoto fascia angusta postice, segmento dorsali primo fascia angusta apicali, segmentis dorsalibus et ventralibus 2-6 fascia angusta apicali bisinuata, coxis subtus, tibiis tarsisque anterioribus supra, intermediisque subtus albido-flavis; alis hyalinis, venis nigris.*

*Long.* 10-13 mm.

♂. Very slender. Head rugose; thorax strongly and closely punctured, median segment punctured-rugose. Antennae rather slender, as long as the head, thorax, and median segment combined, of even thickness throughout. Pronotum longer than the scutellum, the sides almost parallel, the anterior margin straight, with acute angles, the posterior margin widely arched. Sides of the head and thorax rather thickly clothed with long white pubescence. Median segment longer than broad, rounded posteriorly. Abdomen slender, shining, very finely punctured; the basal segment as long as the second and third combined, petiolate, the narrow petiole nearly as long as the slightly swollen apical portion; second segment broadened from the base, about equal in length to the third, the segments scarcely constricted at the base; the apical dorsal segment convex, subcarinate in the middle, sparsely punctured, the punctures large, the apical incision shallow, not as deep as its breadth at the apex. Wings reaching to the apex of the fourth dorsal segment; second and third abscissæ of the radius usually about equal in length, the fourth distinctly shorter; second recurrent nervure received just before one-third from the base of the third cubital cell, curved outwards in the middle.

*Hab.* Willowmore, Cape Colony (*Dr. Brauns*).

This corresponds rather closely with the description of *Plesia incisa* Cam., but in that description the incision of the apical dorsal segment is said to be twice longer than wide, and some of the details of venuration are not quite the same. But the latter character is of little importance in the genus, especially as to the length of the second and third abscissæ of the radius. Many variations occur which are not of specific value.

ELIS (MESA) ASMARENSIS Turn.

*Plesia asmarensis* Turn. Ann. & Mag. Nat. Hist. (8) iii, p. 481 (1909). ♂.

*Hab.* Erythrea,

## ELIS (MESA) AMETALLA Turn.

*Elis (Mesa) ametalla* Turn. Ann. & Mag. Nat. Hist. (8) vii. p. 305 (1911), ♂.

*Hab.* S. Nyasaland.

Almost certainly the male of *innolata*.

## ELIS (MESA) NODOSA Guér.

*Myzine nodosa* Guér. Dict. pitt. hist. nat. v. p. 584 (1837), ♂;  
Sauss. in Grandidier Hist. Madagascar, xx. p. 240 (1892), ♂.

*Hab.* Madagascar.

## \*ELIS (MESA) CLAVATA SAUSS.

*Myzine clavata* Sauss. in Grandidier, Hist. Madagascar, xx. p. 242 (1892), ♂.

*Hab.* Transvaal.

## \*ELIS (MESA) CARBONARIA Cam.

*Plesia carbonaria* Cam. Rec. Albany Mus. i. p. 317 (1905), ♂.

*Hab.* Dunbrody, Cape Colony.

## \*ELIS (MESA) RETICULATA Cam.

*Plesia reticulata* Cam. Rec. Albany Mus. i. p. 300 (1905), ♂.

*Hab.* Brak Kloof, Cape Colony.

## \*ELIS (MESA) RUFO-FEMORATA Cam.

*Plesia rufob-femorata* Cam. Rec. Albany Mus. i. p. 298 (1905), ♂.

*Hab.* O'okiep, Cape Colony.

## \*ELIS (MESA) INCISA Cam.

*Plesia incisa* Cam. Rec. Albany Mus. i. p. 320 (1905), ♂.

*Hab.* Dunbrody, Cape Colony.

*Key to the Oriental Species of Elis (Mesa).**Females.*

- |  |    |                             |
|--|----|-----------------------------|
| 1. Sixth dorsal segment longitudinally striated .....  | 2. |                             |
| Sixth dorsal segment punctured.....  | 8. |                             |
| 2. Abdomen more or less ferruginous .....  | 3. |                             |
| Abdomen wholly black .....   | 4. |                             |
| 3. Clypeus with a median carina; two apical abdominal<br>segments and the apex of the fourth black.....    |    | <i>E. dimidiata</i> Guér.   |
| Clypeus without a distinct carina; apical abdominal<br>segment only black .....                            |    | <i>E. mandalensis</i> Magr. |
| 4. Median segment distinctly margined posteriorly .....  |    | <i>E. fuscipennis</i> Sm.   |
| Median segment not distinctly margined posteriorly...  | 5. |                             |
| 5. Wings fuscous .....   | 6. |                             |
| Wings subhyaline.....  | 7. |                             |
| 6. Pronotum longitudinally rugose; second abscissa of<br>the radius as long as the third. Length 16 mm.... |    | <i>E. mandibularis</i> Sm.  |
| Pronotum coarsely punctured; second abscissa of the<br>radius much shorter than the third. Length 10 mm.   |    | <i>E. petiolata</i> Sm.     |

- |  |                                |
|--|--------------------------------|
| 7. Propleurae sparsely punctured .....                     | <i>E. claripennis</i> Bingham. |
| Propleurae finely striated .....                           | <i>E. astulata</i> Turn.       |
| 8. Abdomen not marked with yellow .....                    | 9.                             |
| Abdominal segments with yellow apical bands .....          | * <i>E. picticollis</i> Mor.   |
| 9. Head black; abdomen black or black and ferruginous.     | 10.                            |
| Head red; abdomen steel-blue .....                         | <i>E. tricolor</i> Sm.         |
| 10. Abdomen mostly ferruginous .....                       | 11.                            |
| Abdomen entirely black, or with the apical segment         | 12.                            |
| only ferruginous .....                                     | <i>E. bengalensis</i> Cam.     |
| 11. Four basal segments of the abdomen ferruginous .....   | <i>E. apinacata</i> Cam.       |
| Four apical segments of the abdomen ferruginous .....      | 13.                            |
| 12. Apical segment of the abdomen ferruginous .....        | 14.                            |
| Apical segment of the abdomen black .....                  | * <i>E. fetschenko</i> Sauss.  |
| 13. Mesonotum closely punctured .....                      | * <i>E. debilis</i> Mor.       |
| Mesonotum shining, almost impunctate .....                 | <i>E. cotinopis</i> Cam.       |
| 14. Legs ferruginous; head coarsely and closely punctured. | <i>E. optefrons</i> Turn.      |
| Legs black; head sparsely punctured .....                  |                                |

*Myzine anthracina* recorded by Bingham as Indian is Australian and belongs to the genus *Anthoboscia*; and *Myzine comburga* also recorded as Indian is undoubtedly West Indian, and a true *Elis*.

#### Males.

- |  |                                |
|--|--------------------------------|
| 1. First dorsal segment elongate, petiolate, more or less nodose at the apex .....   | 2.                             |
| First dorsal segment subsessile, not nodose at the apex broader at the apex than long .....  | <i>E. dimidiaticornis</i>      |
| 2. Seventh dorsal segment distinctly incised at the apex; abdomen wholly black .....   | [Bingh.]                       |
| Seventh dorsal segment not incised at the apex .....   | 3.                             |
| 3. Legs black; seventh dorsal segment smooth and shining at the apex .....   | 4.                             |
| Legs fusco-ferruginous; seventh dorsal segment coarsely punctured .....  | <i>E. burmanica</i> Bingham.   |
| 4. Abdomen wholly black, without yellow markings, sometimes glossed with blue .....  | <i>E. lata</i> Bingham.        |
| Abdomen more or less marked with yellow .....  | 5.                             |
| 5. Median segment without a distinct sulcus; pygidial area clearly defined, with marginal carinae reaching nearly to the base of the segment .....             | 6.                             |
| Median segment with a distinct median sulcus; pygidial area less clearly defined, the marginal carinae lower and only on the apical third of the segment ..... | <i>E. dimidiata</i> Guér.      |
| 6. First abdominal segment very little, if at all longer than the hind femur and trochanter combined .....   | <i>E. mandibularis</i> Sm.     |
| First abdominal segment much longer than the hind femur and trochanter combined .....  | 7.                             |
| 7. Head punctured-rugose; pronotum without a yellow band .....   | 8.                             |
| Head punctured; pronotum with a yellow band on the posterior margin .....  | <i>E. nursei</i> Turn.         |
| 8. Wings hyaline; pronotum with a yellow band on the posterior margin, closely punctured .....   | <i>E. mandalensis</i> Magr.    |
| Wings pale fusco-hyaline; pronotum without a yellow band, rather sparsely punctured .....  | 9.                             |
| 9. Narrow petiole of first abdominal segment scarcely more than half as long as the swollen apical portion of the segment .....                                | <i>E. extensa</i> Turn.        |
| Narrow petiole of first abdominal segment nearly as long as the swollen apical portion of the segment ...  | <i>E. petiolata</i> Sm.        |
|  | <i>E. claripennis</i> Bingham. |

*Myzine pallida* Sm. and *Myzine orientalis* Sm., placed by Bingham and Smith in *Myzine*, together with many species of *Elis*,

belong to the genus *Iswara* Westw., which also belongs to the Elidinae.

ELIS (MESA) DIMIDIATA Guér.

*Myzine dimidiata* Guér. Dict. pitt. hist. nat. v. p. 584 (1837), ♂.

*Methoca orientalis* Sm. Cat. Hym. B. M. iii, p. 66 (1855), ♂ (nec Smith, 1875).

*Myzine madraspatana* Sm. Cat. Hym. B. M. iii, p. 72 (1855), ♀.

*Myzine violaceipennis* Cam. Mem. Manchester Lit. & Phil. Soc. xlii, p. 21 (1898), ♀.

*Hab.* The whole of India, except the North-West.

♀. Head and thorax coarsely rugosely punctured, smooth round the anterior ocellus and at the base of the mesonotum; median segment opaque, with a narrow median sulcus in which is a low carina, the sides of the sulcus raised and forming low carinae, the segment not margined at the base of the posterior truncation. Radial cell distinctly separated from the costa for more than half its length, third abscissa of the radius very distinctly longer than the second. Sixth dorsal segment finely longitudinally striated; basal joint of hind tarsi with a scopa of short hairs beneath.

Black; second, third, and the base of the fourth abdominal segments ferruginous. Calcaria whitish; wings fusco-violaceous.

♂. Head and thorax closely punctured; median segment rugose; basal third of first abdominal segment forming a narrow petiole, apical two-thirds swollen and slightly constricted at the apex, the whole segment more than half as long again as the second segment. Abdomen shining, very finely punctured; pygidial area coarsely punctured, fully twice as long as broad, the sides raised and forming carinae, a well-defined median carina, the apex narrowly truncate, not emarginate.

Black; the abdomen slightly glossed with blue; base of the mandibles, fore tibiae in front, fore tarsi in front, base of the tegulae and the hind margin of the pronotum narrowly and obscurely pale yellow. Wings hyaline at the base, fusco-hyaline beyond the basal nervure.

Length 17 mm.

The association of the sexes was suggested by me in 1908, and positive proof was published by Mr. Lefroy a year later, a pair having been taken *in coitu* by Mr. Dutt at Pusa.

ELIS (MESA) MANDIBULARIS Sm.

*Methoca mandibularis* Sm. Trans. Ent. Soc. London, p. 301 (1869), ♂.

*Plesia (Mesa) mandibularis* Turn. Ann. & Mag. Nat. Hist. (8) i. p. 509 (1908), ♂.

*Plesia (Mesa) purpureipennis* Turn. Ann. & Mag. Nat. Hist. (8) i. p. 508 (1908), ♀.

This will almost certainly prove to be the Chinese subspecies

of *E. dimidiata* Guér., from which the female differs in the entirely black abdomen and the greater length of the second abscissa of the radius, which is nearly as long as the third. The male differs from *dimidiata* in having the second abscissa of the radius very distinctly longer than the third, in the paler colour of the apical portion of the wings, in the presence of a distinct longitudinal sulcus on the median segment, and in the somewhat shorter and broader form of the first abdominal segment. The pygidial area of the male is also wider and less distinctly margined than in *dimidiata*.

*Hab.* Shanghai.

ELIS (MESA) BENGALENSIS Cam.

*Myiæ bengalensis* Cam. Mem. Manchester Lit. & Phil. Soc. xlii. p. 21. (1898). ♀.

The four basal abdominal segments are ferruginous; the wings violaceous, the base of the hind wings hyaline. Pronotum sparsely but coarsely punctured.

Length 15 mm.

This is quite distinct from *dimidiata*, and seems, as Cameron suggests, to be more nearly related to *mandalensis*.

ELIS (MESA) MANDALENSIS Magr.

*Plesia mandalensis* Magr. Ann. Mus. Civ. Gen. (2) xii. p. 257 (1892), ♀.

♀. The five basal abdominal segments are ferruginous. Calcaria and spines of the hind tibiae whitish. Wings hyaline, dark fusco-hyaline beyond the basal nervure of the fore wing to the apex, the apex of the hind wing fusco-hyaline. Pronotum closely and somewhat coarsely punctured; sixth dorsal segment finely longitudinally striated.

♂. Head and thorax closely and rather finely punctured; median segment punctured-rugose; abdomen shining, microscopically punctured. First abdominal segment scarcely longer than the hind femur and trochanter combined, the narrow petiole a little more than half as long as the moderately swollen apical portion of the segment; second segment longer than the third by about one-quarter. Seventh dorsal segment pointed, not incised; pygidial area well defined, very narrow, coarsely punctured and with a well-marked median carina. Third abscissa of the radius distinctly longer than the second.

Black; mandibles at the base, clypeus, apex of the inter-antennal prominence, posterior margin of the pronotum, tegulae, an apical band on dorsal segments 1-6, strongly bisinuate on segments 2-6 and on ventral segments 2-6, tarsi, fore and intermediate tibiae in front, and the base of the hind tibiae yellow. Wings hyaline, nervures fuscous.

Length, ♀ 10 mm., ♂ 10-11 mm.

*Hab.* Mandalay, Burma.

Taken *in copuli* by Colonel Bingham.

## ELIS (MESA) ROTHNEYI Cam.

*Myzine rothneyi* Cam. Ann. & Mag. Nat. Hist. (7) x. p. 88 (1902), ♀.

♀. This fine species is easily distinguished, being black with ferruginous legs; the wings fusco-hyaline, flushed with purple. The sixth dorsal segment is coarsely punctured, the punctures tending to become confluent longitudinally towards the apex. Head and thorax very coarsely punctured, rugose on the pronotum.

*Hab.* Khasi Hills, Assam.

## ELIS (MESA) FUSCIPENNIS Sm.

*Myzine fuscipennis* Sm. Cat. Hym. B. M. iii. p. 72 (1855), ♀; Bingham, Fauna Brit. India, Hymen. i. p. 67 (1897), ♀.

♀. This species may be distinguished from the female of *petiolata* Sm., which it closely resembles, by the sharply margined median segment, the posterior slope of which is abrupt and steep, not gradual as in *petiolata*. The colour is black; the calcaria whitish, mandibles fusco-ferruginous, wings fuscous. The spines on the outer margin of the hind tibiae are black in *fuscipennis*, whitish in *petiolata*.

Length 12 mm.

*Hab.* India.

The type is unique in the British Museum collection and was obtained from Shuckard in exchange, so that the locality is uncertain. Bingham's description is taken from the type, but he evidently confused the species with *petiolata*, a specimen of which is labelled *fuscipennis* by him in the British Museum collection. I have not seen the specimens he records from Burma, but consider it very doubtful if they belong to this species.

## ELIS (MESA) PETIOLATA Sm.

*Myzine petiolata* Sm. Cat. Hym. B. M. iii. p. 72 (1855), ♂.

*Myzine ceylonica* Cam. Ann. & Mag. Nat. Hist. (7) v. p. 18 (1900), ♀.

*Plesia (Mesa) petiolata* Turn. Ann. & Mag. Nat. Hist. (8) i. p. 512 (1908), ♂ ♀.

♀. Differs from *fuscipennis* Sm. in the absence of a distinct margin separating the dorsal surface of the median segment from the surface of the posterior slope and in the white spines of the hind tibiae. From *claripennis* Bingham, it differs in the fuscous colour of the wings, the somewhat coarser puncturation, and the lesser length of the second abscissa of the radius, which is only about half as long as the third in *petiolata* and almost or quite as long as the third in *claripennis*. In *fuscipennis* the second abscissa of the radius is shorter than in *petiolata*, being distinctly less than half as long as the third.

♂. This is very near the male of *claripennis*, but may be distinguished by the less elongate petiole, the narrow basal portion of which is scarcely more than half as long as the moderately swollen apical portion of the segment.

Length, ♂ ♀, 10 mm.

*Hab.* Bengal, Bombay, and Ceylon.

ELIS (MESA) CLARIPENNIS Bingh.

*Myzine claripennis* Bingh. Fauna Brit. India, Hymen. i. p. 68 (1897), ♀.

*Myzine hortata* Nurse, Journ. Bombay Nat. Hist. Soc. xiv. p. 81 (1902), ♀.

♀. Differs from *petiolata* as noticed under that species. Bingham's description of the species is inaccurate as to the median segment, and this has misled Nurse. The segment is not smooth and shining, and the longitudinal impression, though not very long, cannot be said to be triangular.

♂. The male, which has not been previously described, closely resembles *petiolata* Sm. Head and thorax closely punctured, most coarsely on the front, median segment rugose; abdomen very slender, shining, minutely punctured. First abdominal segment more than half as long again as the hind femur, the narrow petiole very little shorter than the feebly swollen apical portion; second segment very narrow at the base, nearly half as long again as the third segment. Seventh dorsal segment not incised at the apex, pointed, convex and without a distinct pygidial area.

Black; mandibles, clypeus, the apex of the interantennal prominence, posterior margin of the pronotum, an apical narrow band on dorsal segments 1-6, strongly bisinuate on segments 2-6, base of the tegulae, fore tarsi, anterior and intermediate tibiae in front, base of hind tibiae and base of intermediate and hind tarsi pale yellow. Wings hyaline, nervures fuscous.

Length, ♂ 8 mm., ♀ 10 mm.

*Hab.* Burma, Ceylon, Bengal, and Deesa.

The male has the two basal abdominal segments more slender than in *petiolata*, the first with the apical portion less swollen, the basal narrow petiole longer in proportion; the second narrower at the base.

ELIS (MESA) USTULATA Turn.

*Plesia (Mesa) ustulata* Turn. Ann. & Mag. Nat. Hist. (8) i. p. 510 (1908), ♀.

♀. This is nearest to *claripennis* Bingh., but is a larger and more robust species, somewhat more closely punctured, with the wings distinctly darker and the punctures on the abdomen larger.

*Hab.* Yunzalin Valley, Tenasserim.



*ELIS (MESA) OPACIFRONS* Turn.

*Plesia (Mesa) opacifrons* Turn. Ann. & Mag. Nat. Hist. (8) i. p. 509 (1908), ♀.

♀. This black species may be distinguished by the very sparse puncturation of the head, pronotum, and sixth dorsal segment. The wings are pale fusco-hyaline. It is a larger and more robust species than *petiolata*.

*Hab.* Salwen Valley, Tenasserim.

\**ELIS (MESA) DUBIA* Mor.

*Plesia dubia* Mor. Hor. Soc. Ent. Ross. xxiv. p. 627 (1890), ♀.

This species is black, with the apical abdominal segment, tarsi, hind tibiae, mandibles, and antennae beneath ferruginous, the mesonotum shining and almost impunctate, the sixth dorsal segment finely and closely punctured.

Length  $11\frac{1}{2}$  mm.

*Hab.* Turkestan.

*PLESIA (MESA) APIMACULA* Cam.

*Myzine apimacula* Cam. Journ. Bombay Nat. Hist. Soc. xiv. p. 272 (1902), ♀.

♀. This is allied to *dubia* Mor., but differs in having the four apical abdominal segments ferruginous, the wings paler, and the puncturation somewhat different.

*Hab.* Deesa, N.W. India.

The male described as belonging to this species by Colonel Nurse is *Pecilotiphia albomaculata* Cam., but has three cubital cells instead of two as in the type of the species, which is evidently an aberration from the usual neurulation. The male has the form of a *Myzine*, not of a *Mesa*, but it is by no means improbable that Nurse is correct in the association of the sexes, though he informs me that he does not recollect his reasons for placing them together. The apical dorsal segment is deeply incised as in *Myzine*. Cameron's action in forming a new genus on a specimen with abnormal neurulation is quite unjustified and due to ignorance of the variable character of neurulation in the Scoliidæ, but I am at present doubtful if *Pecilotiphia* should be treated as a synonym of *Myzine* or of *Elis (Mesa)*.

\**ELIS (MESA) FEDTSCHENKOI* Sauss.

*Plesia fedtschenkoi* Saussure in Fedtschenko: Turkestan, Scoliidæ, p. 29 (1880), ♀ (*Plesia tartara* on plate).

*Plesia tartara* Sauss. l.c. pl. ii. fig. 12, ♀.

This seems to differ from *dubia* Mor. in the coarser and closer puncturation of the mesonotum. The name *tartara* is used on the plate through a fault in the editing, and has unfortunately been recorded in Dalla Torre's Catalogue as a distinct species.

## \*ELIS (MESA) PICTICOLLIS Mor.

*Plesia picticollis* Mor. Hor. Soc. Ent. Ross. xxiv. p. 624 (1890), ♀.

This appears to be a very distinct species, strongly marked with yellow on the head, thorax, and abdomen. The colour would suggest an *Anthobosca* allied to *A. arabica* Turn., but the structure of the apical abdominal segment and the indistinct striation of the metapleuræ render it unlikely that it belongs to that genus.

## ELIS (MESA) TRICOLOR Sm. (Pl. LXXXI. fig. 16; Pl. LXXXII. fig. 11.)

*Myzine tricolor* Sm. Journ. Linn. Soc., Zool. ii. p. 91 (1858), ♀.

This fine species is easily distinguished by the large size (19 mm.), the bright red head, and steel-blue abdomen. The wings are fusco-hyaline, flushed with purple, almost hyaline at the base. The head is large, quadrate, sparsely punctured, smooth on the vertex; pronotum coarsely punctured, median segment subconcave on the posterior slope; sixth dorsal segment strongly punctured. Second abscissa of the radius nearly as long as the first and third combined.

*Hab.* Borneo (typical); Dibrugarh, Assam; W. India (*T. R. Bell*).

The only specimen I have seen from Assam has the head distinctly longer than broad, longer behind the eyes than in the typical form, and the scape and three basal joints of the flagellum are red; the median segment is not at all concave on the posterior slope. The differences will probably prove to be subspecific. Mr. Bell informed me that he bred this species from the larva of a longicorn beetle.

## ELIS (MESA)? DIMIDIATICORNIS Bingh. (Pl. LXXXI. fig. 15.)

*Myzine dimidiaticornis* Bingh. Journ. Linn. Soc., Zool. xxv. p. 423 (1896), ♂; Turn. Ann. & Mag. Nat. Hist. (8) i. p. 501 (1908), ♂.

♂. Antennæ stout, a little longer than the thorax and median segment combined. Front rugose, vertex sparsely punctured. Pronotum transversely rugulose, much longer than the mesonotum, the sides almost parallel. Head slightly narrowed and produced from behind the eyes. Thorax and median segment rugose, the median segment distinctly margined posteriorly and vertically truncate. First abdominal segment vertically truncate anteriorly, with a distinct transverse carina above the base of the truncation, attached to the abdomen by a very short petiole, nearly as broad as the second segment, the sides parallel. Apical dorsal segment not incised at the apex. Without a pygidial area. Second abscissa of the radius as long as the first and third combined.

Black; scape and four basal joints of the flagellum, clypeus, and apex of the interantennal prominence dull ferruginous; abdomen glossed with steely blue. Wings hyaline; fusco-

violaceous from the basal nervure of the fore wing to the apex and at the apex of the hind wing.

Length 13 mm.

*Hab.* Kumaon, N.W. India.

Although this resembles *Myzine* rather than *Elis* in the form of the first abdominal segment and the antennæ, I consider that it will probably be found to be the male of *E. tricolor* Sm. The proportions of the cubital cells, the colour of the abdomen and antennæ, and the colour of the wings are all very similar in the two forms and unlike any other species, either of *Myzine* or *Elis*. I consider it probable that the group of *Elis* containing *dubia*, *fedtschenkoi*, and *apimacula* will also be found to have males showing the facies of *Myzine* rather than of *Elis*. These cases render it very difficult to reach absolute certainty in distinguishing the males of *Elis* from *Myzine*, though all males with a long petiole may be assigned to *Elis*.

I think *Methoca rugosa* Cam. (Mem. Manchester Soc. 1896) from Ceylon will prove to be a local form of this species, and also an individual aberration as far as the loss of one of the transverse cubital nervures is concerned. It is certainly not a *Methoca*.

ELIS (MESA) NURSEI Turn.

*Plesia nursei* Turn. Ann. & Mag. Nat. Hist. (8) iii. p. 480 (1909), ♂.

The first abdominal segment is no longer than the hind femur and trochanter combined, the narrowed petiole being rather less than half as long as the strongly dilated apical portion of the segment. In general appearance there is a strong resemblance to *petiolata*, but there is no yellow band on the pronotum and sixth abdominal segment. It is also a larger species, and the shorter petiole is a good distinguishing character, in which the resemblance is nearer to *mandalensis* than to *petiolata*.

*Hab.* Simla.

ELIS (MESA) EXTENSA Turn.

*Plesia (Mesa) extensa* Turn. Ann. & Mag. Nat. Hist. (8) i. p. 511 (1908), ♂.

The first abdominal segment is much longer than the hind femur and trochanter combined; the antennæ are longer than the head, thorax, and median segment combined. The wings are strongly suffused with yellowish brown, and the yellow bands on the abdomen are reduced to short transverse lines on each side of dorsal segments 2-5.

Length 12 mm.

*Hab.* Upper Burma.

ELIS (MESA) LETA Bingh.

*Myzine leta* Bingh. Faun. Brit. India, Hymen. i. p. 70 (1897), ♂.

♂. Black; the legs fusco-ferruginous; wings hyaline. First

abdominal segment a little longer than the hind femur and trochanter combined, the narrow petiole about half as long as the dilated apical portion; seventh dorsal segment distinctly incised at the apex, the incision nearly as deep as its apical width; second segment about half as long again as the third. Second abscissa of the radius distinctly longer than the third. Pygidial area clearly defined and strongly punctured. Hind tibiae more distinctly serrate than in other species of the genus.

Length 9-11 mm.

*Hab.* Moulmein, Tenasserim.

ELIS (MESA) BURMANICA Bing.

*Myzine burmanica* Bing. Faun. Brit. India, Hymen. i. p. 70 (1897), ♂.

♂. This differs from *leta* in the black colour of the legs; the pygidial area is flatter, less distinctly punctured, and not distinctly margined, and the third abscissa of the radius is distinctly longer than the second. Whether these differences are of specific value or not it is not easy to say from a single specimen of each, but I am inclined to regard them as merely variations of one species.

*Hab.* Amherst, Tenasserim.

ELIS SELLOWI, sp. n.

♀. *Nigra*; *postscutello linea transversa, segmento dorsali primo macula magna utrinque, segmentisque dorsalibus 2-5 fascia basali angusta utrinque flavis*; *femoribus, tibiis tarsisque rufo-testaceis*; *mandibulis fusco-ferrugineis*; *alis fusco-hyalinis, costa obscura, venis fuscis*.

Long. 11-13 mm.

♀. Clypeus strongly punctured, broadly rounded at the apex, with a longitudinal carina from the base almost reaching the apex. Front strongly and closely punctured, vertex and ocellar region sparsely and less deeply punctured, cheeks smooth, an arched impressed mark above the posterior ocelli; scape strongly punctured. Thorax deeply and closely punctured, especially on the pronotum and mesopleurae, the disc of the mesonotum and the scutellum rather sparsely punctured; propleurae obliquely striated. Median segment closely punctured in the middle, opaque and almost smooth near the anterior angles; the posterior slope almost vertical, concave in the middle and shagreened, with short transverse striae on the sides, the sides of the segment strongly striated. Abdomen shining, with a few scattered punctures; the apical segment closely longitudinally striated, with a few large punctures between the striae, very broadly rounded at the apex. The three abscissae of the radius almost equal in length; first recurrent nervure received just beyond the middle of the second cubital cell, second just beyond one-quarter from the base of the third cubital cell. The ventral abdominal

segments are very sparsely punctured, with a row of piliferous punctures near the apex; the pubescence is whitish.

*Hab.* San Juan del Rey, Brazil (*Sellow*). Two specimens.

Type in the Berlin Museum.

*ELIS MAJOR*, sp. n.

♀. *Nigra*; *fascia angusta transversa supra antennis, margine interiore oculorum anguste, linea pone oculos, postscutello, segmentis dorsalibus primo secundoque macula magna obliqua utrinque, segmentisque 3-5 fascia lata sub-basali flavis; mandibulis, tibiis tarsisque fuscis; alis flavo-hyalinis, venis testaceis.*

*Long.* 24 mm.

♀. Clypeus coarsely punctured, broadly rounded at the apex, raised and longitudinally carinate in the middle. Front coarsely punctured, the prominence between the antennae almost transverse at the apex, vertex and ocellar region a little more sparsely punctured, cheeks very sparsely and more finely punctured; posterior ocelli nearly twice as far from the eyes as from each other. Thorax closely and coarsely punctured, especially on the pronotum and mesopleurae; propleurae finely obliquely striated. Median segment smooth, opaque, rugosely punctured in the middle, with a few irregular transverse striae at the apex and also on the sides of the posterior truncation; the sides of the segment striated, with a small yellow band near the apical angle. Abdomen shining, with a few scattered punctures, the apical segment closely longitudinally striated and broadly rounded at the apex. Ventral segments smooth, more or less punctured at the apex. First and third abscissae of the radius about equal in length, the second nearly half as long again. First recurrent nervure received beyond the middle, sometimes at two-thirds from the base of the second cubital cell, second received between the middle and one-quarter from the base of the third cubital cell. Calcaria whitish.

*Hab.* Central Brazil (*Sellow*).

Described from three specimens in the Berlin Museum.

The probable male of this species has the usual yellow markings: the mandibles, clypeus, a small spot on each side above the base of the antennae, the margins of the pronotum, interrupted in the middle on the anterior margin, the tegulae, a spot on the mesonotum, one on the centre of the scutellum, a large spot on the mesopleurae below the anterior wings and another before the intermediate coxae, the postscutellum, a lateral longitudinal band on each side of the posterior slope of the median segment, apical bands on dorsal segments 1-6, straight and narrow on segments 4-6, broader and shallowly emarginate on segments 2-3 and very deeply emarginate on the first segment, the tibiae, tarsi, and the greater part of the femora yellow. No yellow spots on the apical segment. Wings hyaline, nervures black. Emargination of the apical segment broader at the apex than deep, the dorsal surface

of the segment flattened and distinctly margined laterally, shallowly longitudinally depressed in the middle and sparsely punctured; the basal segment distinctly less than twice as long as the breadth at the apex. Clypeus broadly rounded or subtruncate at the apex, not emarginate. Second recurrent nervure received at the base of the third cubital cell, almost interstitial with the second transverse cubital nervure; third abscissa of the radius a little longer than the second. Pronotum slightly emarginate anteriorly.

Length 19 mm.

The details of neururation in the Elidinae are not reliable for specific differences, often showing slight differences on the opposite sides of the same insect. The really important distinctions in the males of *Elis* are to be found in the structure of the apical and basal segments of the abdomen.

*ELIS COMBUSTA* Sm. (Pl. LXXXII. fig. 12.)

*Myzine combusta* Sm. Descr. new spec. Hymen. p. 179 (1879), ♀; Bingham, Faun. Brit. Ind., Hymen. i. p. 67 (1897), ♀.

The type is from Shuckard's collection. I do not know why Smith gave the locality as India or Africa, nor why Colonel Bingham included it in the Fauna of India without any note of doubt. The structure is that of the true American section of *Elis*, and I look on it as a mere colour-variety, or possibly a local race confined to one island, of *E. ephippium* Fabr., a West Indian species which I have recorded from St. Thomas, St. John, Antigua, and Porto Rico.

### Subfamily ANTHOBOSCINÆ.

#### Genus ANTHOBOSCA Guér.

*Anthobosca* Guér. Voy. 'Coquille,' Zool. ii. p. 214 (1839).

*Cosila* Guér. Voy. 'Coquille,' Zool. ii. p. 249 (1839).

*Dimorphoptera* Sm. Trans. Ent. Soc. London, p. 238 (1868).

*Myzine* Burm. Stett. ent. Zeit. xxxvii. p. 168 (1876) (nec Latreille).

*Odontothynnus* Cam. Rec. Albany Mus. i. p. 161 (1904).

*Austrotiphia* Cockerell, Bull. Mus. Comp. Anat. Harvard, p. 49 (1906).

*Geotiphia* Cockerell, Bull. Mus. Comp. Anat. Harvard, p. 49 (1906).

*Anthobosca* Turn. Proc. Linn. Soc. N.S.W. xxxii. p. 514 (1907).

There has been so much confusion in connection with this interesting genus that I think it may be useful to give a short account of the species, which may serve as a basis for a future monograph. Owing to the great differences between the sexes, they were for a long time placed in different families, most of the

males being placed in *Anthobosca* in the Thynnidae, and the females in *Cosila* among the Scoliidae. Guérin used both names in the same work, but although he placed *Cosila chilensis* correctly, with the Scoliidae, he failed to see the relationship to *Anthobosca australasiae* which he had described in an earlier portion of the same work and classed with the Thynnidae. Smith in 1868 placed a single male in his genus *Dimorphoptera*, which is a synonym of *Cosila*, but both before and after placed other males in *Anthobosca* among the Thynnidae. He also described both sexes of *A. albomaculata* Sm., which were taken coupled by Bates, as *Myzine*, but this work was published after his death and without his revision. Burnmeister also in 1876 correctly associated the sexes, but placed his species in *Myzine*. Although three or four males had been correctly associated with the females, they do not appear to have been connected in any way with the males described in the genus *Anthobosca* till my revision of the Australian species of the genus appeared in 1907. The best work on the genus was done by Saussure in 1892; but he treated the males as unknown, except in the case of *chilensis*, and did not connect *Cosila* with *Anthobosca*. In Dalla Torre's great Catalogue, published in 1897, there is much confusion in regard to this genus, species appearing under the genera *Thynnus*, *Myzine*, and *Cosila*. There is much confusion over the genus in the recent papers of Cameron on South African Hymenoptera. Ashmead treats the group as a family, Cosilidae, not as a subfamily of the Scoliidae, which I consider the more natural course. But he places *Anthobosca* in the Thynnidae and *Dimorphoptera* in his family Myzinidae. He includes in his family Cosilidae several genera of doubtful affinities, of which, in my opinion, *Nursea* should be treated as an aberrant genus of the Sphecoidea, whilst *Maurillus* belongs to the Pompilidae. The position of *Sierolomorpha* and *Dicrogenium* seems to me very doubtful, but I have not seen specimens. I am compelled to look on *Anthobosca* as the only genus which can be placed in the subfamily Anthoboscinae with any certainty. Ashmead states that the intermediate coxae in his Cosilidae are contiguous or nearly so; but this is quite incorrect as to the females, and even in the males the separation is quite distinct. In my key to the species I have included several species which I have not seen, one or two of which may possibly not belong to the genus.

The females are distinguished from other Scoliidae by the absence of a deep groove between the two basal ventral segments of the abdomen. The hind coxae are separated as in *Tiphia*, not contiguous as in *Elis*; but the intermediate coxae are less widely separated than in either of those groups, though very little less so than in *Elis*. The males are distinguished from all other Scoliidae by the unarmed rounded hypopygium—in this character approaching most nearly to the Thynnidae of the genus *Virone*.

It is quite possible that the genus will have to be subdivided owing to differences of structure, especially in the tarsal ungues, which in most of the Australian species have a blunt lobe at the base, but in the African, South American, and a few Australian species are bifid. The venuration is so variable, even in the same species, that I do not consider that genera should be founded on the shape of the radial cell alone, on which character the subgenera *Colobosila* Sichel and *Callosila* Saussure have been based. In two Australian species the cell is acute at the apex, in others blunt, and African species may similarly be divided into two groups. But until more species are known in both sexes any subdivision would be rash and unnecessary.

The geographical distribution of the genus is interesting, being almost entirely Southern, including Australia (where the species are most numerous), South America as far north as the Amazon, Madagascar and South Africa spreading up the East African coast to Suakin and crossing to Aden. I am aware that many regard similar cases of distribution as a proof of southern origin, and explain them by former northern extensions of the Southern continent connecting at different times with southern extensions of the land in the Southern Hemisphere. But taking into consideration the enormous depth of the Southern oceans I cannot look on this explanation as satisfactory, and think that it is more reasonable to look on this and other similar cases of distribution as instances of the survival in the south of genera which in former times had a much more extensive range. It has been pointed out by Darwin that the struggle for existence is more severe on large land-areas than on smaller ones, owing to the more complex conditions of life from the larger number of existing species which are able to come into competition. Now the land-areas in the south are very much smaller than in the north, so that it is reasonable to suppose that many genera may have been able to survive in the south with little or no modification, which have been exterminated by the more severe struggle for existence in the north. In this case we should expect to find fossil remains of such genera, or at all events of nearly related forms, in the north; and in a great number of cases such fossils have been found. In the present genus I look on Cockerell's *Geotiphia* found fossil in Colorado as absolutely congeneric with existing South-American species; and the plant genus *Araucaria* and many others, which are now southern, had in early geological times a wide range in the Northern Hemisphere. It may, of course, be argued that such genera originally had their home in the south and at one time extended their range northward, but in that case it may be conceded that they may have reached the different portions of the Southern Hemisphere by way of the north and not from a southern continent. I must own to an objection to calling up continents from the extreme ocean depths "*nisi dignus vindice nodus.*"



*Key to the Species of Anthobosca.**Females.*

- |  |     |                                |
|--|-----|--------------------------------|
| 1. Species from the Old World.....   | 2.  |                                |
| South-American species .....   | 23. |                                |
| 2. Australian species .....  | 3.  |                                |
| African and Arabian species .....  | 16. |                                |
| 3. Tarsal ungues with a lobe at the base either rounded or pointed... ..   | 4.  |                                |
| Tarsal ungues without a basal lobe, deeply bifid .....   | 14. |                                |
| 4. Radial cell pointed at the apex .....   | 5.  |                                |
| Radial cell blunt at the apex .....  | 6.  |                                |
| 5. Pubescence black, calcaria black, abdomen wholly black .....  |     | <i>A. australis</i> Sichel.    |
| Pubescence whitish, calcaria white, abdomen usually with a yellow spot on each side of the third dorsal segment .....  |     | <i>A. signata</i> Sm.          |
| 6. Wings short, the length of the costa of the fore wing not exceeding two and a half times the breadth of the mesonotum. Pronotum, median segment, and three basal abdominal segments rufo-testaceous ... |     | <i>A. fastuosa</i> Sm.         |
| Wings longer, the length of the costa of the fore wing three times as great as the breadth of the mesonotum. Thorax and abdomen black .....  | 7.  |                                |
| 7. Antennae orange; stigma about three times as long on the costa as broad .....   |     | <i>A. flavicornis</i> Sauss.   |
| Antennae black or fuscous; stigma scarcely more than twice as long on the costa as broad .....   | 8.  |                                |
| 8. Legs bright ferruginous .....   | 9.  |                                |
| Legs black, sometimes fusco-ferruginous beneath ...  | 10. |                                |
| 9. Second abscissa of the radius no longer than the third; first recurrent nervure received just before the middle of the second cubital cell .....  |     | <i>A. cognata</i> Sm.          |
| Second abscissa of the radius longer than the third; first recurrent nervure received at one-quarter from the base of the second cubital cell .....  |     | <i>A. strandi</i> Turn.        |
| 10. Wings fuscous; four basal abdominal segments with ciliae of white scale-like hairs .....   | 11. |                                |
| Wings hyaline or subhyaline; abdominal segments without ciliae of scale-like hairs .....   | 12. |                                |
| 11. Pronotum and scutellum strongly punctured .....  |     | <i>A. albopilosa</i> Turn.     |
| Pronotum and scutellum sparsely and very finely punctured .....  |     | <i>A. argenteocincta</i> Grib. |
| 12. Third cubital cell nearly as long on the radius as on the cubitus or longer; first recurrent nervure received slightly beyond the middle of the second cubital cell .....                              |     | <i>A. anthracina</i> Sm.       |
| Third cubital cell much shorter on the radius than on the cubitus; first recurrent nervure received well before the middle of the second cubital cell ...  | 13. |                                |
| 13. Front punctured; legs wholly black; length 11 mm. Front smooth and shining; legs fusco-ferruginous beneath; length 7 mm.....   |     | <i>A. unicolor</i> Sm.         |
|  |     | <i>A. laevifrons</i> Sm.       |
| 14. Abdomen black; second and third cubital cells each receiving a recurrent nervure .....   | 15. |                                |
| Abdominal segments 2-4 very broadly rufo-testaceous at the base; second cubital cell receiving both recurrent nervures .....   |     | <i>A. clypeata</i> Sm.         |
| 15. Sixth dorsal segment strongly striated at the base; radial cell detached from costa for half its length. Sixth dorsal segment punctured; radial cell detached from costa at extreme apex only .....    |     | <i>A. nubilipennis</i> Turn.   |
|  |     | <i>A. occipitalis</i> Turn.    |
| 16. Radial cell subacute at apex; abdomen not marked with yellowish white.....   | 17. |                                |
| Radial cell broadly rounded or narrowly truncate at apex; abdomen marked with yellowish white .....  | 20. |                                |

- |   |                                |
|---|--------------------------------|
| 17. Apical segment at least of abdomen red; wings fusco-violaceous.....                                       | 18.                            |
| Abdomen wholly black; wings flavo- or fusco-hyaline.  | 19.                            |
| 18. Apical abdominal segment only red; thorax not coarsely punctured .....                                    | * <i>A. melanaria</i> Cam.     |
| Two apical abdominal segments red; thorax very coarsely sculptured .....                                      | * <i>A. donaldsoni</i> Fox.    |
| 19. Wings flavo-hyaline; third transverse cubital nervure received close to the apex of the radial cell ..... | <i>A. insularis</i> Sm.        |
| Wings fusco-hyaline; fourth abscissa of the radius as long as the first.....                                  | <i>A. natalica</i> Turn.       |
| 20. Radial cell narrowly truncate at apex. Length 5 mm.   | <i>A. minima</i> Turn.         |
| Radial cell broadly rounded at apex. Length 9 mm.   |                                |
| or more .....   | 21.                            |
| 21. Head and thorax black with pale yellow markings ...   | 22.                            |
| Head and thorax without yellow markings, thorax black or more or less red .....                               | <i>A. erythronota</i> Cam.     |
| 22. Abdomen ferruginous.....  | * <i>A. sauckineusis</i> Magr. |
| Abdomen black .....   | <i>A. arabica</i> Turn.        |
| 23. Abdomen black without markings .....  | 24.                            |
| Abdomen marked with yellow or white .....   | 25.                            |
| 24. Antennae orange; head and thorax closely punctured.   | <i>A. chilensis</i> Guér.      |
| Antennae black; head and thorax very sparsely punctured .....   | <i>A. carbonaria</i> Burm.     |
| 25. Wings flavo-hyaline; abdomen with four or five interrupted yellow bands.....                              | 26.                            |
| Wings fusco-hyaline; abdomen with one or two yellowish lateral spots .....                                    | 27.                            |
| 26. Legs ferruginous .....  | <i>A. antennata</i> Sm.        |
| Legs black .....  | * <i>A. erythropyga</i> Burm.  |
| 27. Vertex smooth and shining; third dorsal segment only with lateral spots .....                             | <i>A. bipunctata</i> Perty.    |
| Vertex sparsely punctured; second and third dorsal segments with whitish lateral spots .....                  | <i>A. albomaculata</i> Sm.     |

1. *ANTHOEOSCA AUSTRALIS* Sichel. (Pl. LXXXII. figs. 1, 2; Pl. LXXXIII. figs. 1, 3, 6, 14.)

*Cosila australis* Sichel, Sauss. et Sichel, Cat. spec. gen. *Scolia*, p. 261 (1864), ♀.

*Dimorphoptera scoliiformis* Sm. Trans. Ent. Soc. London, p. 238 (1868), ♀.

*Cosila (Callosila) australis* Sauss. in Grandidier, Hist. Madagascar, xx. p. 232 (1892), ♀.

*Dimorphoptera nigripennis* Sm. Trans. Ent. Soc. London, p. 239 (1868), ♂.

♀. The radial cell is pointed and detached from the costa at the apex, receiving the second transverse cubital nervure close to the middle, the second abscissa of the radius almost as long as the third. First recurrent nervure received close to the middle of the second cubital cell, second at one-third from the base of the third cubital cell. Third cubital cell fully half as long again on the cubital as on the radial nervure. Basal lobe of tarsal unguis bluntly rounded. Basal joint of hind tarsi with a scopa beneath, in which is a row of longer black spines. Sparsely punctured, shining; pronotum and scutellum more closely punctured; pygidium densely clothed with long black pubescence.

Black, with black pubescence. Wings fusco-violaceous.

Length 28 mm.

♂. Second abscissa of the radius about half as long as the third. Basal lobe of tarsal unguis bluntly rounded. Apical joint of the flagellum about half as long again as the penultimate and slightly curved; the eighth, ninth, tenth, and eleventh joints subtuberculate in the middle beneath. Posterior tibiae very feebly spined on the outer margin. Pronotum short, scarcely narrowed anteriorly. First abdominal segment very little longer than the second, broader at the apex than long. Head and thorax closely and not very minutely punctured.

Black, with cinereous pubescence, calcaria black. Wings fusco-violaceous.

Length 17 mm.

*Hab.* E. Coast of Australia between Sydney and Brisbane.

The association of the sexes is not certain. The structure of the male antennae is very remarkable.

## 2. ANTHOBOSCA SIGNATA Sm.

*Myzine signata* Sm. Cat. Hym. B. M. iii. p. 75 (1855), ♀.

*Cosila biguttata* Sichel, Sauss. et Sichel Cat. spec. gen. *Scolia*, p. 262 (1864), ♀.

*Dimorphoptera signata* Sm. Trans. Ent. Soc. London, p. 238 (1868), ♀.

*Cosila (Callosila) signata* Sauss. in Grandidier, Hist. Madagascar, xx. p. 232 (1892), ♀.

Var. *Dimorphoptera morosa* Sm. Trans. Ent. Soc. London, p. 239 (1868), ♀.

♀. Radial cell pointed and detached from the costa at the apex, second recurrent nervure received at about one-quarter from the base of the second cubital cell. Other details of venation as in *australis* Sichel. Basal joint of hind tarsi with a comb of thickly set spines beneath. Basal lobe of tarsal unguis bluntly rounded. Shining and sparsely punctured, the front and pronotum more closely punctured; sixth dorsal segment of abdomen rugosely punctured.

Black, with whitish pubescence, the calcaria white. Wings fusco-violaceous. Third dorsal segment with an orange spot on each side.

Length 22 mm.

*Hab.* E. Australia, from Sydney to Cairns.

I look on *morosa* as a small variety in which the orange spots on the abdomen are wanting. The second abscissa of the radius is distinctly shorter than the third in the type of *morosa*, owing to the sharp curve toward the base in the second transverse cubital nervure, but I do not think that this distinction is of specific importance.

## 3. ANTHOBOSCA FASTUOSA Sm. (Pl. LXXXI. fig. 3.)

*Dimorphoptera fastuosu* Sm. Trans. Ent. Soc. London, p. 240 (1868), ♀.

*Myzine fastuosa* D. T. Cat. Hym. viii. p. 123 (1897).

PROC. ZOOLOG. SOC.—1912, No. XLVIII.

♀. Wings short, the length of the costa of the fore wing not exceeding two and a half times the breadth of the mesonotum. Radial cell broad, the apex detached from the costa and narrowly rounded. Third abscissa of the radius nearly half as long again as the second, and more than twice as long as the first; second transverse cubital nervure received at about two-fifths from the base of the radial cell. Second cubital cell not very strongly produced towards the base on the cubitus, receiving the first recurrent nervure near the middle, second recurrent nervure received just beyond one-quarter from the base of the third cubital cell. Basal joint of hind tarsi finely pectinate beneath; basal joint of fore tarsi with six spines above and about eight shorter ones beneath; basal lobe of tarsal unguis bluntly rounded. Sparsely punctured, more closely on the front, pronotum, and abdomen; the apical abdominal segments more strongly punctured than the three basal segments.

Rufo-testaceous; head, mesothorax, and three apical abdominal segments black; mandibles at the base and scape fusco-ferruginous; pubescence rufo-testaceous. Wings hyaline, tinged with yellow; nervures testaceous, the stigma black.

Length 17 mm.

*Hab.* Champion Bay, W. Australia.

The process beneath the hind femora near the apex is much less developed in this species than in most Australian species, though the femora are by no means convex beneath as in most of the South-American species and in *A. nubilipennis*.

#### 4. *ANTHOBOSCA FLAVICORNIS* SAUSS.

*Cosila* (*Callosila*) *flavicornis* SAUSS. in Grandidier, Hist. Madagascar, xx. p. 233 (1892), ♀.

♀. Radial cell with a slight angle at the apex; second abscissa of the radius shorter than the first, the third longer than the first and second combined, third cubital cell of about equal length on the radial and cubital nervures. Second cubital cell much produced towards the base on the cubitus; first recurrent nervure received about the middle of the second cubital cell, second just before the middle of the third cubital cell. Basal joint of hind tarsi with a scopa beneath, in which are a few spines longer than the hairs; basal joint of fore tarsi with six stout spines above and a row of very fine spines beneath; basal lobe of tarsal unguis rounded. The lobe beneath the apical portion of the hind femora has the lower margin nearly straight, only very slightly rounded, and is strongly developed. Shining and rather sparsely punctured, the anterior half of the pronotum and the median segment closely and finely punctured and sub-opaque.

Black, with white pubescence; the flagellum orange; calcaria white, the spines of the tibiae and tarsi reddish brown. Wings fusco-hyaline, nervures fuscous.

Length 11-14 mm.

*Hab.* Victoria.

There is also a specimen in the National Collection from Tasmania and another from Cairns, Queensland. In the former the radial cell is rounded at the apex and the tibiae and tarsi are reddish; in the latter the radial cell is almost truncate at the apex, though narrowly, and the second abscissa of the radius is as long as the first. I do not think that small differences of neururation in this genus will prove to be of specific value.

#### 5. *ANTHOBOSCA COGNATA* Sm.

*Dimorphoptera cognata* Sm. Descr. new spec. Hymen. p. 188 (1879), ♀.

♀. Radial cell rather broadly rounded at the apex; the four abscissae of the radius of about equal length; the third cubital cell much longer on the cubitus than on the radius. Recurrent nervures received close to the middle of the second and third cubital cells; the second cubital cell strongly produced toward the base on the cubitus. Basal joint of hind tarsi with a scopa beneath in which are five or six longer spines; basal joint of fore tarsi with six long and rather slender spines above and a closely set row of very small spines beneath; basal lobe of tarsal unguis less bluntly rounded than in *flavicornis*. The lobe beneath the apical half of the hind femora is very broadly rounded. Closely and finely punctured, more finely and closely on the abdomen and median segment than on the head and thorax, some larger punctures on the disc of the mesonotum.

Black, with sparse whitish pubescence; mandibles at the base and legs, except the coxæ, ferruginous.

Length 11 mm.

*Hab.* Swan River, Western Australia.

#### 6. *ANTHOBOSCA STRANDI* Turn.

*Anthobosca strandi* Turn. Proc. Zool. Soc. London, p. 306 (1910), ♀.

♀. Radial cell broadly rounded at the apex; second abscissa of the radius twice as long as the first and distinctly longer than the third; first recurrent nervure received at one-quarter from the base of the second cubital cell, second at one-fifth from the base of the third cubital cell. Apical lobe beneath the hind femora broadly rounded and strongly developed. Pronotum, median segment, and abdomen very finely and closely punctured, front coarsely and closely, mesonotum and scutellum less coarsely and rather sparsely punctured.

Black; the pubescence pale fulvous on the head and pronotum, grey on the sides of the abdomen, fusco-ferruginous on the apical dorsal segment; apex of the scape and flagellum beneath fusco-ferruginous, a dull ferruginous spot on each side close to the summit of the eyes; mandibles at the base, tegulae, tibiae, tarsi.

femora at the apex, and the whole of the hind femora ferruginous. Wings subhyaline, nervures fuscous, stigma ferruginous.

Length 13 mm.

*Hab.* E. Australia; probably from Victoria.

I have not a specimen of this species before me at the time of writing.

#### 7. ANTHOBOSCA ALBOPILOSA Turn.

*Anthobosca albopilosa* Turn. Proc. Linn. Soc. N.S.W. xxxii. p. 520 (1907), ♀.

♀. Radial cell slightly angular at the apex; third abscissa of the radius the longest, but shorter than the first and second combined, the first scarcely as long as the second. First recurrent nervure received near the middle of the second cubital cell, second just beyond one-quarter from the base of the third cubital cell. Second cubital cell less strongly produced towards the base than in *flavicornis*. Basal joint of hind tarsi with a scopa beneath, in which are a few longer spines; basal joint of fore tarsi with six or seven well-developed spines below and the usual six above; basal lobe of tarsal unguis rounded; lobe beneath the apical half of the hind femora broadly rounded and less strongly developed than in *flavicornis*. Deeply and rather closely punctured, the abdomen more shallowly punctured.

Black; the pubescence on the head and sides of the thorax white, on the abdomen and dorsal surface of the thorax black; calcaria black; four basal dorsal segments of abdomen and ventral segments 2-4 with apical ciliae of scale-like white hairs. Wings fuscous, with faint violet reflections.

Length 14 mm.

*Hab.* Queensland.

#### 8. ANTHOBOSCA ARGENTEOCINCTA Grib.

*Cosila argenteocincta* Gribodo, Ann. Mus. Civ. Stor. Nat. Genova, xviii. p. 261 (1883), ♀.

♀. Radial cell with a slight angle at the apex; second abscissa of the radius longer than the first, the third equal to the first and second combined, the third cubital cell a little longer on the cubitus than on the radius. First recurrent nervure received just beyond the middle of the second cubital cell, second at one-third from the base of the third cubital cell; the second cubital cell moderately produced towards the base on the cubitus. Basal joint of hind tarsi with a close row of small spines beneath; basal joint of fore tarsi with seven spines above, and a close-set row of slender spines beneath; basal lobe of tarsal unguis bluntly rounded; lobe beneath the basal half of the posterior femora broadly rounded. Shining, finely and very sparsely punctured; the median segment subopaque and very finely and closely punctured on the sides; abdomen shallowly but much more coarsely punctured.

Black, with sparse grey pubescence; flagellum beneath fuscous; tarsal unguis ferruginous; calcaria white. Wings light fuscous, shaded with bronze; nervures black.

Length 13 mm.

*Hab.* Adelaide, S. Australia.

I think I have identified this species correctly. Gribodo mentions a tubercle at the base of the first ventral segment, which does not seem to be any more developed in the specimen described above than in other species.

9. *ANTHOBOSCA ANTHRACINA* Sm. (Pl. LXXXII. fig. 3.)

*Myzine anthracina* Sm. Cat. Hym. B. M. iii. p. 71 (1855), ♀.

*Myzine sabulosa* Sm. Cat. Hym. B. M. iii. p. 76 (1855), ♀.

*Dimorphoptera anthracina* Sm. Trans. Ent. Soc. London, p. 238 (1868).

*Dimorphoptera sabulosa* Sm. Trans. Ent. Soc. London, p. 238 (1868).

*Ausrotiphia kirbyi* Cockerell, Bull. Mus. Comp. Anat. Harvard, p. 49 (1906), ♀.

♀. Radial cell very bluntly rounded at the apex; second abscissa of the radius shorter than the first, the third abscissa half as long again as the first and second combined. First recurrent nervure received just beyond the middle of the second cubital cell, which is more sharply produced towards the base than in *unicolor* Sm. or *levifrons* Sm.; second recurrent nervure received at two-fifths from the base of the third cubital cell, which is longer on the radius than on the cubitus. Basal joint of hind tarsi finely pectinate beneath; basal joint of fore tarsi with six spines above and eight finer beneath; basal lobe of tarsal unguis bluntly rounded. Finely and rather sparsely punctured, pronotum more coarsely punctured, median segment very finely and closely punctured with a smooth line in the middle.

Black with whitish pubescence; spines of the tibiae and tarsi white, those of the anterior pair slightly reddish. Wings hyaline, shaded with fuscous towards the apex, nervures pale testaceous.

Length 14 mm.

*Hab.* S.E. Australia; Adelaide to Sydney.

The description is taken from the type of *anthracina*. The type of *sabulosa* has the first and second abscissæ of the radius about equal in length, combined equal to the third; the third cubital cell no longer on the radius than on the cubitus; the nervures are fuscous. But excepting in these points I cannot detect any difference, and do not consider that small differences of neuration can be held to be of specific importance, considering how much variation occurs in other groups of Scoliidæ in such detail. The type of *Ausrotiphia kirbyi* is similar to *sabulosa*.

## 10. ANTHOBOSCA UNICOLOR Sm.

*Myzine unicolor* Sm. Cat. Hym. B. M. iii. p. 75 (1855), ♀.

*Dimorphoptera unicolor* Sm. Trans. Ent. Soc. London, p. 238 (1868), ♀.

*Cosila (Callosila) minuta* Sauss. in Grandidier, Hist. Madagascar, xx. p. 233 (1892), ♀.

♀. Radial cell rounded at the apex; second abscissa of the radius as long as the first, the two combined a little longer than the third; first recurrent nervure received a little before the middle of the second cubital cell, second before one-third from the base of the third cubital cell, which is much longer on the cubitus than on the radius; second cubital cell not very strongly produced towards the base. Basal joint of hind tarsi with a few small spines beneath; basal lobe of tarsal unguis rounded; lobe on the apical third of the hind femora beneath not very strongly prominent. Shining and sparsely punctured, the front closely and strongly punctured; median segment subopaque, very finely and closely punctured.

Black, with white pubescence; mandibles and scape beneath fuscous; calcaria white. Wings hyaline, faintly tinted with fuscous.

Length 10 mm.

*Hab.* Eastern Australia; Tasmania to Cairns.

## 11. ANTHOBOSCA LEVIFRONS Sm.

*Dimorphoptera levifrons* Sm. Descr. new spec. Hymen. p. 188, (1879), ♀.

*Myzine levifrons* D. T. Cat. Hymen. viii. p. 124 (1897).

♀. Radial cell broadly rounded at the apex; second abscissa of the radius shorter than the first, the two combined longer than the third; first recurrent nervure received at two-fifths from the base of the second cubital cell, second just before the middle of the third cubital cell, which is much longer on the cubitus than on the radius. Basal joint of hind tarsi with a row of fine hairs beneath, in which are two or three longer spines; the lobe beneath the apical third of the hind femora broadly rounded. Basal lobe of tarsal unguis small and blunt. Shining, head and thorax very sparsely punctured, the front smooth; median segment and abdomen closely and minutely punctured.

Black, with sparse white pubescence; mandibles, flagellum beneath, and legs beneath fusco-ferruginous. Wings hyaline, tinged with fuscous; nervures fusco-ferruginous.

Length 7 mm.

*Hab.* Adelaide, S. Australia.

## 12. ANTHOBOSCA OCCIPITALIS, sp. n.

♀. *Nigra, vertice macula utrinque supra oculos fusco-sanguinea; unguiculis bifidis; alis subhyalinis, venis fusco-ferrugineis.*

*Long.* 14 mm



♀. Radial cell rounded at the apex; third abscissa of the radius shorter than the second; third cubital cell as long on the radius as on the costa; first recurrent nervure received just beyond one-third from the base of the second cubital cell, second at one-fifth from the base of the third cubital cell; second cubital cell not very strongly produced towards the base. Tarsal unguis bifid, without a basal lobe; basal joint of hind tarsi with rather long hairs beneath; lobe beneath the apical half of the hind femora broadly rounded. Closely punctured; rather strongly on the head, finely on the thorax, coarsely on the scutellum, rather sparsely and shallowly on the abdomen; sixth dorsal segment rather broadly truncate at the apex.

Black, with grey pubescence, a fusco-sanguineous spot on the vertex on each side close to the summit of the eyes; sixth dorsal segment fuscous at the apex, calcaria whitish.

*Hab.* S. Australia; probably from Adelaide.

This species is remarkable for the very long second abscissa of the radius, and may be easily distinguished from the majority of Australian species by the bifid tarsal unguis.

### 13. ANTHOBOSCA NUBILIPENNIS Turn.

*Anthobosca nubilipennis* Turn. Proc. Zool. Soc. London, p. 307 (1910), ♀.

♀. Radial cell detached from the costa for fully half its length, slightly angular at the apex; second abscissa of the radius longer than the first and about equal in length to the third; first recurrent nervure received beyond two-thirds from the base of the second cubital cell, second before one-quarter from the base of the third cubital cell, which is nearly twice as long on the cubitus as on the radius. Tarsal unguis bifid, without a basal lobe; hind femora convex beneath, the lobe not apical but almost medial; basal joint of hind tarsi with three or four short spines beneath. Deeply but not very closely punctured; mesonotum and scutellum very sparsely punctured; sixth dorsal abdominal segment coarsely striated at the base, rounded at the apex.

Black, with white pubescence; calcaria black. Wings fusco-hyaline, nervures fuscous; the stigma small. Median segment abruptly truncate.

Length 16 mm.

*Hab.* Perth district, S.W. Australia.

A very distinct species in the characters of the hind legs, neurulation, and median segment.

### 14. ANTHOBOSCA CLYPEATA Sm. (Pl. LXXXI. fig. 2; Pl. LXXXII. fig. 5; Pl. LXXXIII. fig. 7.)

*Dimorphoptera clypeata* Sm. Trans. Ent. Soc. London, p. 239 (1868), ♀.

♀. Radial cell rounded at the apex, detached from the costa

at the extreme apex only; second abscissa of the radius twice as long as the first and about equal in length to the third; second cubital cell receiving both recurrent nervures, the first at one-third from the base, the second just before the apex; third cubital cell as long on the radius as on the cubitus. Tarsal unguis bifid; lobe beneath the apical half of the hind femora strongly rounded; basal joint of hind tarsi with a row of short hairs beneath, in which are a few longer spines. Closely punctured; the thorax very closely and finely punctured, with larger and sparser punctures intermixed; abdomen shining and sparsely punctured.

Black, with whitish pubescence; sixth dorsal segment densely clothed with long golden hairs; clypeus except at the apex and the margins of the eyes broadly interrupted on the summit, yellow; basal two-thirds of dorsal segments 2-4 and of ventral segments 2-3 enarginate in the middle posteriorly, rufo-testaceous. Wings subhyaline, nervures fusco-ferruginous.

Length 22 mm.

*Hab.* Swan River, W. Australia.

An obscure scar runs from the base of the stigma to close to the base of the first transverse cubital nervure. I have little doubt that the male of this species will prove to be *A. crassicornis* Sm., which corresponds with it in the position of the recurrent nervures, the bifid tarsal unguis, and also to some extent in the colour of the clypeus and abdomen.

\*15. *ANTHOBOSCA FASCICULATA* Sichel.

*Cosila (Colobosila) fasciculata* Sichel, Sauss. et Sichel, 'Nat. spec. gen. *Scolia*, p. 263 (1864), ♀.

*Hab.* Australia.

I fail to recognise this species with any certainty, but do not consider that the subgenus *Colobosila* can stand, the truncation of the apex of the radial cell being insufficient as a subgeneric character unless supported by others.

\*16. *ANTHOBOSCA INORNATA* Sauss.

*Cosila inornata* Saussure in Grandidier, Hist. Madagascar, xx. p. 233 (1892), ♀.

I do not recognise this species as a synonym of any known to me, though it seems to be related to *A. anthracina*, differing in the position of the first recurrent nervure. Considering how unreliable the details of venation are in this genus, it is quite possible that it is only a variety of *anthracina*.

\*17. *ANTHOBOSCA MELANARIA* Cam.

*Plesia melanaria* Cam. Rec. Albany Mus. i. 5, p. 297 (1905), ♀.

♀. From the description I have no doubt that this is an *Anthobosca*, the characters "apex of radial cell sharply pointed," and "pygidium piceous red, its base fringed with long, bright rufous hair," and "metapleuræ smooth," agreeing much better

with *Anthobosca* than *Plesia*. Although the two genera belong to different subfamilies of the Scoliidae, the females are likely to be confused by a beginner. Cameron places male Scoliidae of the subfamily Anthoboscinæ in the Thynnidae, and females of the same group with the Scoliidae of the subfamily Elidinae.

\*18. *ANTHOBOSCA DONALDSONI* FOX.

*Cosila donaldsoni* Fox, Proc. Acad. Philadelphia, p. 549 (1896), ♀.

♀. Third transverse cubital nervure received close to the apex of the radial cell. Clypeus tridentate on the anterior margin. Head and thorax very coarsely punctured, pronotum and scutellum scabrous; median segment finely striato-punctate, the sides obliquely striated; abdomen strongly but sparsely punctured, sixth dorsal segment striato-punctate; tarsal unguis cleft.

Black, with greyish pubescence; two apical abdominal segments red; calcaria whitish. Wings black, strongly violaceous.

Length 18 mm.

*Hab.* Somaliland.

I have not seen this species, but the description corresponds almost exactly with *Elis aliciae* described in this paper, though the clypeus in that species is not distinctly tridentate. But I do not believe that Fox would have confused the genera.

19. *ANTHOBOSCA INSULARIS* Sm. (Pl. LXXXII. fig. 6; Pl. LXXXIII. fig. 8.)

*Myzine insularis* Sm. Descr. new spec. Hymen. p. 178 (1879), ♀.

*Cosila insularis* Saussure in Grandidier, Hist. Madagascar, xx. p. 231 (1892), ♀.

♀. Radial cell subacute at the apex, receiving the third transverse cubital nervure very near the apex, in some specimens almost at the apex; second abscissa of the radius longer than the first, the two combined not quite as long as the third; first recurrent nervure received at two-fifths from the base of the second cubital cell, second at one-quarter from the base of the third cubital cell, which is nearly or quite as long on the radius as on the cubitus. Tarsal unguis bifid; hind femora very broadly rounded beneath on the apical two-thirds, basal joint of hind tarsi with three long spines beneath. Shining and sparsely punctured, closely on the front and closely and very finely on the median segment.

Black, with black pubescence; calcaria brown. Wings flavo-hyaline, nervures ferruginous.

Length 23-29 mm.

*Hab.* Madagascar.

The type has a rufous spot in the middle of the first dorsal segment, and obscure reddish shading on the head and thorax.

20. *ANTHOBOSCA NATALICA* Turn.

*Anthobosca natalica* Turn. Trans. Ent. Soc. London, p. 85 (1908), ♀.

♀. Radial cell narrowly rounded at the apex, subacute; third abscissa of the radius twice as long as the second, the fourth shorter than the first; first recurrent nervure received just beyond the middle of the second cubital cell, second before the middle of the third cubital cell, which is as long on the radius as on the cubitus. Tarsal unguis bifid; basal joint of hind tarsi with a scopa beneath. Shining and sparsely punctured, more closely on the front and pronotum; median segment very finely and closely punctured; abdomen finely but more sparsely punctured.

Black; pubescence on the apical dorsal segment brown and long; tegulae and extreme apical margin of the abdominal segments testaceous brown; calcaria whitish; fore tarsi fusco-ferruginous. Wings fusco-hyaline, nervures fusco-ferruginous.

Length 12–17 mm.

*Hab.* Malvern, Natal.

The neurulation given is as in the type, but in another specimen the second abscissa of the radius is much more than half as long as the third, and both recurrent nervures are received nearer the base of the cells.

21. *ANTHOBOSCA ERYTHRONOTA* Cam. (Pl. LXXXI. figs. 5, 6; Pl. LXXXII. fig. 4.)

*Plesia erythronota* Cam. Rec. Albany Mus. i. 5, p. 320 (1905).

♀. *Nigra*; *prothorace, mesothorace, tibiis tarsisque rufo-ferrugineis*; *segmentis abdominalibus 2–4 macula laterali alba utrinque*; *alis fusco-hyalinis, venis nigris*.

♂. *Niger, gracilis*; *mandibulis basi, clypeo, oculis margine interiore, pronoto late postice, tegulis, mesonoto macula, mesopleuris macula, scutello macula mediana, postscutello macula mediana transversa, segmentisque abdominalibus 2–4 macula magna transversa utrinque albido-flavis*; *pedibus nigris albo-variegatis*; *alis hyalinis, venis nigris*.

*Variat* ♀ *prothorace mesothoraceque nigris*.

*Long.*, ♀ 10–11 mm., ♂ 8–11 mm.

♀. Clypeus shining in the middle and somewhat flattened, narrowly truncate at the apex. Head convex, broader than long, not much broader than the thorax; rather sparsely punctured, the space round the base of the antennae closely punctured and clothed with fulvous hairs. Eyes touching the base of the mandibles, the line of the interior margin slightly undulating; posterior ocelli much nearer to each other than to the eyes. Thorax rather sparsely punctured; pronotum slightly emarginate anteriorly, the posterior margin widely but not strongly arched; the projection of the mesosternum between the intermediate coxae very deeply bilobed. Median segment very finely and closely

punctured, the posterior slope very steep. Abdomen rather closely punctured; the apical margins of the segments rather broadly depressed and smooth, more broadly in the middle than at the sides, the apical segment testaceous and thickly covered with fulvous bristles. Radial cell bluntly rounded at the apex, not detached from the costa; second abscissa of the radius a little longer than the first, but scarcely more than half as long as the third, the third cubital cell longer on the radius than on the cubitus, second recurrent nervure received at about one-quarter from the base of the third cubital cell. Ungues cleft.

♂. Clypeus slightly convex, rather narrowly truncate at the apex and armed with a row of three very minute teeth. Antennæ no longer than the thorax and median segment combined, tapering slightly towards the apex. Eyes convergent towards the clypeus, the inner margin almost straight. Head and thorax finely and closely punctured; pronotum strongly narrowed anteriorly, the anterior margin slightly emarginate, posterior margin strongly arched. Abdomen shagreened, very slender, slightly tapering to the extremities, the basal segment distinctly longer than the second. Hind tibiæ finely serrate, all the tarsal unguis cleft. Second abscissa of the radius half as long again as the first and only a little more than half as long as the third, second recurrent nervure received at about one-quarter from the base of the third cubital cell.

*Hab.* Willowmore, Cape Colony; November to January (*Dr. Brauns*).

The male comes very near Cameron's genus *Odontothynnus*, which I have elsewhere treated with some doubt as a synonym of *Anthobosca*; but Cameron states that the posterior tarsal unguis in his genus are simple. Even if he is correct as to this character it would not be sufficient to justify the formation of a genus on one sex only, and his remarks show that he has no knowledge of the genus *Anthobosca*. I suspect that the present species may prove to be identical with *Plesia leucospila* Cam., with the description of which it agrees fairly well, but the mesopleuræ are rather strongly though not very closely punctured, not almost smooth as in Cameron's description. In the broadly rounded apex of the radial cell this species differs from *A. natalica* Turn., in which the cell is subacute, but agrees with *A. arabica* Turn.

\*22. *ANTHOBOSCA LEUCOSPILA* Cam.

*Plesia leucospila* Cam. Rec. Albany Mus. i. 5, p. 319 (1905), ♀.

♀. It is almost certain that Cameron has misplaced this species. It is possibly identical with *A. erythronota* Cam., which has a similar colour variety, in which case the name *leucospila* should be used for the species. But Cameron states that the pleuræ are almost smooth, whereas in *erythronota* the mesopleuræ

are strongly though not closely punctured. But this is possibly an error in Cameron's description.

\*23. *ANTHOBOSCA SAUAKINENSIS* Magr.

*Myzine sauakinensis* Magr. Ann. Mus. Civ. Genova, xxi. p. 560 (1884), ♀.

I think it probable that *A. arabica* Turn. is only a colour variety of this species, with the abdomen black instead of ferruginous. The difference in size between the two forms is considerable, but both size and colour vary much in this genus. But as I have not seen *sauakinensis* I think it better to keep the two separate at present.

24. *ANTHOBOSCA ARABICA* Turn.

*Anthobosca arabica* Turn. Trans. Ent. Soc. London, p. 397 (1910), ♀.

♀. Radial cell broadly rounded at the apex; second abscissa of the radius longer than the first, the two combined equal in length to the third, first recurrent nervure received a little before the middle of the second cubital cell, second before one-third from the base of the third cubital cell, which is as long on the radius as on the cubitus. Tarsal unguis bifid; the lobe beneath the hind femora occupying nearly the whole length of the joint and scarcely rounded; basal joint of fore tarsi with a comb of nine rather short spines on the outer margin and a row of short fine spines on the inner margin, the outer angle strongly produced and almost reaching the apex of the second joint. Shining, finely and sparsely punctured, more closely on the front and pronotum.

Black, with grey pubescence, a narrow band on the inner margin of the eyes, continued and arched on the vertex, a spot on the front, hind margin, and anterior angles of the pronotum, a curved band on the scutellum, a median spot and the posterior angles on the median segment, and a transverse band on each side on dorsal segments 1-4 pale yellow; mandibles, tegulae, tarsi, and pygidium testaceous brown.

Length 9 mm.

*Hab.* Aden district.

25. *ANTHOBOSCA MINIMA* Turn.

*Anthobosca minima* Turn. Trans. Ent. Soc. London, p. 398 (1910), ♀.

♀. Radial cell narrowly truncate at the apex; second abscissa of the radius more than twice as long as the first, but much shorter than the third. Tarsal unguis bifid. Shining, sparsely and finely punctured; apical dorsal segment strongly punctured and covered with stiff fulvous hairs.

Black; mandibles, antennae, and legs testaceous brown;

abdomen dark reddish brown; yellow marks as in *arabica*, but the yellow band on each side of the first dorsal segment is absent.

Length 5 mm.

*Hab.* Mombasa.

## 26. ANTHOBOSCA CHILENSIS Guér.

*Cosila chilensis* Guér. Voy. 'Coquille,' Zool. ii. p. 249 (1839), ♀; Spinola, in Gay's Hist. Fis. Chile, Zool. vi. p. 312 (1851), ♂ ♀.

*Myzine flavicornis* Sm. Descr. new spec. Hymen. p. 183 (1879), ♀.

♀. Radial cell rounded at the apex; second abscissa of the radius twice as long as the first, but distinctly shorter than the third; first recurrent nervure received close to the middle of the second cubital cell, second at about one-fifth from the base of the third cubital cell. Tarsal unguis bifid; lobe beneath the apical third of the hind femora scarcely rounded, basal joint of hind tarsi with a thinly-set row of very short spines beneath. Finely and rather closely punctured, median segment finely rugulose; abdomen shining, very finely and sparsely punctured. Basal joint of fore tarsi not strongly produced at the outer apical angle.

Black, with long black pubescence; calcaria black; flagellum bright orange. Wings fusco-violaceous.

♂. Third abscissa of the radius twice as long as the second in some specimens, shorter than the second in others; first recurrent nervure received by the second cubital cell at a distance from the base slightly less than the length of the first transverse cubital nervure, second either interstitial with the second transverse cubital nervure or received a little before the apex of the second cubital cell. Apical joint of antennæ no longer than the penultimate. Basal abdominal segment nearly twice as broad at the apex as long. Very finely and closely punctured, minutely on the abdomen.

Colours as in the female.

Length, ♀ 22 mm., ♂ 16 mm.

*Hab.* Chile.

## 27. ANTHOBOSCA CARBONARIA Burm.

*Myzine carbonaria* Burm. Stett. ent. Zeit. xxxvii. p. 168 (1876), ♀.

*Anthobosca carbonaria* Turn. Trans. Ent. Soc. London, p. 83 (1908), ♀.

*Cosila carbonaria* Bréthes, Ann. Mus. Buen. Aires, xx. p. 256 (1910), ♀.

♀. Radial cell narrowly rounded at the apex; second abscissa of the radius longer than the first and third combined; first recurrent nervure received at about two-fifths from the base of

the second cubital cell, second before one-third from the base of the third cubital cell, which is nearly twice as long on the cubitus as on the radius. Basal joint of hind tarsi with a row of fine spines beneath; basal joint of fore tarsi with seven spines above and a row of short spines beneath; tarsal unguis cleft; apical half of hind femora broadly rounded beneath; tarsal unguis cleft. Shining, finely and sparsely punctured; front and pronotum more closely and coarsely punctured; median segment subopaque, very finely and closely punctured, the posterior slope rather indistinctly transversely striated. Pygidium densely clothed with fusco-ferruginous pubescence. Basal joint of fore tarsi not very strongly produced at outer angle.

Black, with grey pubescence; calcaria pale brownish. Wings rather light fuscous, fusco-hyaline at the apex.

Length 20 mm.

*Hab.* Nova Fribourg, S. Brazil.

## 28. ANTHOBOSCA BIPUNCTATA Perty.

*Tiphia bipunctata* Perty, Delect. anim. artic. Brasil. p. 139 (1833), ♀.

*Myzine bipunctata* Sm. Cat. Hym. B. M. iii. p. 76 (1855).

*Anthobosca bipunctata* Turn. Trans. Ent. Soc. London, p. 83 (1908).

♀. Radial cell narrowly rounded at the apex; first and fourth abscissæ of the radius about equal in length, second and third also nearly equal to each other and twice as long as the first; the first recurrent nervure received just beyond two-fifths from the base of the second cubital cell, second at the middle of the third cubital cell, which is shorter on the radius than on the cubitus. Tarsal unguis bifid; lobe beneath the posterior femora extending over the apical two-thirds of their length and scarcely rounded. Shining and very sparsely punctured, the front smooth, apical dorsal segment covered with long fuscous hair. Basal joint of fore tarsi strongly produced at the outer apical angle.

Black; a yellow spot on each side of the third dorsal segment. Wings fusco-hyaline, nervures fuscous; calcaria whitish.

Length 16 mm.

*Hab.* Minas Geraes, Brazil.

Allied to *carbonaria* Burm., but has the lobe beneath the hind femora longer, the basal joint of the fore tarsi is more produced, and the puncturation is sparser. *A. bipunctulata* Turn. is probably the male of this species.

## 29. ANTHOBOSCA ALBOMACULATA Sm. (Pl. LXXXI. figs. 7, 8.)

*Myzine albomaculata* Sm. Descr. new spec. Hymen. p. 181 (1879), ♀ ♂.

*Myzine leointei* Dücke, Rev. entom. p. 146 (1907), ♀.

♀. Radial cell narrowly rounded at the apex; second abscissa



of the radius a little longer than the first, the third longer than the first and second combined; first recurrent nervure received just beyond two-fifths from the base of the second cubital cell, second close to the middle of the third cubital cell. Tarsal ungues bifid; lobe beneath the basal half of the hind femora not very prominent and very feebly rounded; basal joint of hind tarsi with a row of short hairs beneath; basal joint of fore tarsi strongly produced at the outer apical angle. Shining and sparsely punctured; median segment opaque, closely and minutely punctured; apical dorsal segment coarsely punctured and thickly clothed with long fuscous hairs.

Black; a spot on each side near the anterior angles of the pronotum, a spot on the mesonotum, a spot at the base of the median segment and one at each of the posterior angles, and a spot on each side of the second and third dorsal segments yellowish white; calcaria whitish. Wings pale fusco-hyaline, nervures fuscous.

♂. Second abscissa of radius twice as long as first, third about half as long again as second; first recurrent nervure received a little beyond the middle of the second cubital cell, second at two-fifths from the base of the third cubital cell. Tarsal ungues bifid; hind tibiae serrate on the outer margin. Basal abdominal segment nearly half as long again as the breadth at the apex. Finely and rather closely punctured, abdomen finely shagreened.

Black; mandibles, clypeus, scape beneath, a spot on each side of the pronotum, a spot on the mesonotum, a spot on the scutellum, one on the postscutellum, another at the apex of the median segment, the base of the tibiae, and the tarsi pale yellow. Wings hyaline iridescent, nervures nearly black.

Length, ♀ 12 mm., ♂ 9 mm.

*Hab.* Amazon, from Para to Ega.

### 30. *ANTHOBOSCA ANTENNATA* Sm.

*Anthobosca antennata* Sm. Descr. new spec. Hymen. p. 174 (1879), ♂.

*Cosila jheringi* Saussure in Grandidier, Hist. Madagascar, xx. p. 234 (1892), ♀.

*Thynnus antennatus* D. T. Cat. Hymen. viii. p. 101 (1897), ♂.

♀. Radial cell very narrowly rounded at the apex; third abscissa of radius half as long again as the second, which is nearly twice as long as the first, the fourth shorter than the first; first recurrent nervure received a little before the middle of the second cubital cell, second at one-fifth from the base of the third cubital cell. Tarsal ungues bifid; lobe beneath the hind femora commencing near the base and extending to the apex, broadly rounded; basal joint of hind tarsi with a row of very short fine spines beneath; basal joint of fore tarsi strongly produced at the outer apical angle. Shining, very finely and rather sparsely punctured; median segment subopaque, very closely and minutely

punctured; apical dorsal segment densely clothed with long fulvous hairs.

Black; mandibles at the base, antennæ, and legs ferruginous; an interrupted band on the posterior margin of the pronotum, a spot on the mesonotum, one at the base of the median segment and another at each of the posterior angles, and an interrupted band on the four basal dorsal segments, more broadly interrupted on the second than on the other segments, yellow. Wings very pale flavo-hyaline, nervures ferruginous.

♂. Third abscissa of the radius half as long again as the second, which is about equal to the fourth and twice as long as the first; first recurrent nervure received at or a little beyond the middle of the second cubital cell, second at one-third from the base of the third cubital cell. Tarsal unguis bifid; hind tibiae serrate on the outer margin. Antennæ short and stout, tapering to the apex; pronotum rounded anteriorly; first abdominal segment a little longer than the breadth at the apex, the apical dorsal margin of the segment broadly rounded. Finely and closely punctured; abdomen finely shagreened.

Black; mandibles, clypeus, scape beneath, posterior margin of the pronotum broadly, a spot on the mesonotum, one on the scutellum, another on the postscutellum, and the greater part of the tibiae and tarsi yellow. Wings hyaline, nervures fuscous.

Length, ♀ 13-16 mm., ♂ 12-14 mm.

*Hab.* S. Brazil; Rio Grande do Sul.

As I have noticed before, the antennæ in the type of *antennata* are a little shorter and stouter than in the males sent with *jheringi*. This difference may possibly prove to be specific, but I do not think it is.

### \*31. ANTHOBOSCA ERYTHROPYGA Burm.

*Myzine erythropyga* Burm. Stett. ent. Zeit. xxxvii. p. 169 (1876), ♀ ♂.

*Anthobosca erythropyga* Turn. Trans. Ent. Soc. London, p. 83 (1908).

*Cosila erythropyga* Brèthes, Ann. Mus. Buen. Aires, xx. p. 256 (1910).

I have not seen this species. Schrottky suggests that it is identical with *A. jheringi* Sauss., but Burmeister's description gives the legs of the male as red, of the female black, and the five basal abdominal segments in both sexes with lateral yellow spots, whereas in *jheringi* the four basal segments are banded with yellow and the legs red in the female, and the male has the abdomen without yellow marks and the legs yellow and black. I do not think there is sufficient ground for considering the two to be identical, especially as Schrottky had not seen specimens of *jheringi*.

\*32. *ANTHOBOSCA APICALIS* Sichel.

*Cosila apicalis* Sichel, Sauss. et Sichel, Cat. spec. gen. *Scolia*, p. 262 (1864), ♀.

I have not seen this species, which may possibly be identical with *carboxaria* Burm., but the dorsal segments of that species are not reddish laterally.

*Males.*

- |  |  |
|--|--|
| 1. Species from the Old World.....   | 2.   |
| Species from South America.....  | 18.  |
| 2. Australian species .....  | 3.   |
| African species .....  | 14.  |
| 3. Tarsal unguis with a blunt lobe at the base; second and third cubital cells each receiving a recurrent nervure .....  | 4.   |
| Tarsal unguis bifid, without a basal lobe; second cubital cell receiving both recurrent nervures.....  | <i>A. crassicornis</i> Sm.                             |
| 4. Eighth and three following joints of the flagellum subtuberculate beneath, apical joint longer than penultimate and slightly curved. Wings fusco-violaceous... ..   | <i>A. australis</i> Sichel (= <i>nigripennis</i> Sm.). |
| None of the joints of the flagellum subtuberculate beneath, apical joint no longer than penultimate. Wings hyaline or subhyaline .....                                 | 5.   |
| 5. First abdominal segment distinctly longer than the second; fully half as long again as its breadth at the apex .....  | <i>A. australis</i> Guér.                              |
| First abdominal segment not distinctly longer than the second; scarcely, if at all, longer than its apical breadth .....   | 6.   |
| 6. Thorax and abdomen wholly black .....   | 7.   |
| Pronotum at least marked with yellow .....   | 9.   |
| 7. Legs ferruginous .....  | <i>A. varipes</i> Sm.                                  |
| Legs black .....   | 8.   |
| 8. Median segment transversely rugulose, very short and broad; anterior tibiæ black beneath .....  | <i>A. æthiops</i> Sm.                                  |
| Median segment finely punctured, not very short or broad; anterior tibiæ ferruginous beneath .....   | <i>A. nigra</i> Sm.                                    |
| 9. Legs ferruginous.....   | 10.  |
| Legs black, more or less marked with yellow.....   | 11.  |
| 10. Postscutellum yellow, legs marked with yellow; first transverse cubital nervure as long as the second or longer and strongly bent near the cubitus .....           | <i>A. torresensis</i> Turn.                            |
| Postscutellum and legs without yellow markings; first transverse cubital nervure much shorter than the second, and not bent near the cubitus.....                      | <i>A. gilesi</i> Turn.                                 |
| 11. Five basal abdominal segments with yellowish lateral spots; cubitus of hind wing originating just before the transverse median nervure, almost interstitial ... .. | <i>A. moderata</i> Turn.                               |
| Five basal abdominal segments immaculate; cubitus of hind wing originating very distinctly before the transverse median nervure .....                                  | 12.  |
| 12. Seventh dorsal segment with yellowish lateral spots; postscutellum yellowish .....   | 13.  |
| Seventh dorsal segment and postscutellum immaculate ..   | <i>A. frenchi</i> Turn.                                |
| 13. Clypeus black; mesonotum without a yellow spot; hind tibiæ feebly spinose .....  | <i>A. longipalpa</i> Turn.                             |
| Clypeus yellow; mesonotum with a yellow spot; hind tibiæ feebly serrate .....  | <i>A. lagardei</i> Turn.                               |
| 14. Apical margin of clypeus not toothed .....   | 15.  |
| Apical margin of clypeus with two small teeth .....  | 16.  |

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|--|-------------------------------|
| 15. Legs wholly ferruginous; mesonotum with a yellow spot; tegulae black.....  | <i>A. errans</i> Sm.          |
| Legs ferruginous marked with yellow; mesonotum immaculate; tegulae yellow..... | <i>A. flavopicta</i> Turn.    |
| 16. Wings hyaline.....   | 17.                           |
| Apical half of wings with a distinct fusco-violaceous tinge.....               | <i>A. bidentata</i> Cam.      |
| 17. Abdomen immaculate.....  | <i>A. lacteipennis</i> Cam.   |
| Dorsal abdominal segments 2-4 with large yellowish lateral spots.....          | <i>A. erythronota</i> Cam.    |
| 18. Antennae orange; wings fusco-violaceous.....                               | <i>A. chilensis</i> Guér.     |
| Antennae black; wings hyaline.....   | 19.                           |
| 19. Abdomen spotted with yellow.....   | * <i>A. erythropyga</i> Burm. |
| Abdomen immaculate.....  | 20.                           |
| 20. Legs ferruginous.....  | <i>A. bipustulata</i> Turn.   |
| Legs black, marked with yellow.....  | 21.                           |
| 21. Length 13 mm. Yellow band on pronotum entire.....                          | <i>A. antennata</i> Sm.       |
| Length 10 mm. Yellow band on pronotum interrupted.....                         | <i>A. albomaculata</i> Sm.    |

### 33. ANTHOBOSCA AUSTRALASIE Guér. (Pl. LXXXIII. fig. 13.)

*Anthobosca australasie* Guérin; Duperry, Voy. 'Coquille,' Zool. ii. p. 237 (1839), ♂.

*Anthobosca crabroniformis* Sm. Cat. Hym. B. M. vii. p. 59 (1859), ♂.

*Thynnus cathreivii* D. T. Cat. Hym. viii. p. 103 (1897), ♂.

♂. Pronotum much narrowed anteriorly, nearly as long as the scutellum. First dorsal abdominal segment slender, more than half as long again as the apical breadth, much longer than the second segment. Seventh dorsal segment very broadly rounded at the apex. Hind tibiae feebly spined. Third abscissa of the radius longer than the first and second combined; first recurrent nervure received close to the middle of the second cubital cell; second at one-quarter from the base of the third cubital cell; first transverse cubital nervure curved, not sharply bent at the base. Cubitus of the hind wing originating before the transverse median nervure, separated from it by a distance exceeding half the length of that nervure.

Black; mandibles, clypeus, margins of the eyes interrupted on the summit, pronotum very broadly posteriorly, tegulae, a quadrate spot on the mesonotum, a spot on the mesopleurae, the middle of the scutellum and postscutellum, a curved transverse band at the apex of the median segment, an interrupted transverse band on dorsal segments 2-4, sometimes also a spot on each side of the first and fifth segments, a spot on the anterior coxae and a line on the anterior tibiae yellow; legs ferruginous. Wings hyaline, tinged with yellow; nervures ferruginous.

Length 16 mm.

*Hab.* New South Wales, Queensland, as far north as Cairns.

The female is unknown, but the range of the species is about the same as that of *signata* Sm.

34. *ANTHOBOSCA GILESI* Turn.

*Anthobosca gilesi* Turn. Proc. Zool. Soc. London (1910), p. 308, ♂.

♂. Antennæ shorter than the thorax and median segment combined; pronotum much narrowed anteriorly, shorter than the scutellum. First dorsal segment as broad at the apex as long, a little shorter than the second segment. Seventh dorsal segment subtruncate at the apex. Neuration similar to that of *A. australasiae*, but the position of the first recurrent is variable—it is received beyond the middle of the second cubital cell in the type, but at the middle in another specimen.

Black; the base of the mandibles, part of the clypeus, the pronotum very broadly posteriorly, and the tegulae yellow; legs ferruginous. Wings hyaline, nervures fuscous. Calcaria white.

Length 11–14 mm.

*Hab.* Perth, West Australia.

35. *ANTHOBOSCA TORRESENSIS* Turn.

*Anthobosca torresensis* Turn. Proc. Linn. Soc. N.S.W. xxxii. p. 518 (1907), ♂.

♂. Pronotum narrowed anteriorly, nearly as long as the scutellum. First dorsal segment as broad at the apex as long, no longer than the second segment; seventh dorsal segment narrowly truncate at the apex. Second abscissa of the radius shorter than the first, the two combined much shorter than the third. First transverse cubital nervure longer than the second, very sharply bent near the cubitus; first recurrent nervure received close to the middle of the second cubital cell, second beyond one-quarter from the base of the third cubital cell.

Black; legs ferruginous; mandibles at the base, scape beneath, pronotum very broadly posteriorly, postscutellum, and a line on the anterior tibiae yellow. Wings hyaline, nervures fuscous. Calcaria whitish.

The hind tibiae are almost smooth, the spines nearly obsolete. Neuration of hind wing as in *A. australasiae*.

Length 7–8 mm.

*Hab.* Cape York, Queensland.

36. *ANTHOBOSCA VARIPES* Sm.

*Anthobosca varipes* Sm. Cat. Hym. B. M. vii. p. 59 (1859), ♂.

*Thynnus fischeri* D. T. Cat. Hym. viii. p. 106 (1897), ♂.

♂. Pronotum shorter than the scutellum, not very strongly narrowed anteriorly; scutellum with a delicate carina from the base to the apex. First dorsal segment nearly as broad at the apex as long, very little longer than the second segment; seventh dorsal segment broadly subtruncate at the apex. Hind tibiae very feebly serrate. First transverse cubital nervure

oblique, not sharply bent near the cubitus, longer than the second. Second abscissa of the radius about twice as long as the first, the two combined shorter than the third. First recurrent nervure received distinctly beyond the middle of the second cubital cell, second beyond one-third from the base of the third cubital cell. Hind wing as in *A. australasiae*. Apical joint of maxillary palpi as in *A. australasiae*, not filiform and scarcely longer than the penultimate joint.

Black; the legs ferruginous. Wings hyaline, nervures fuscous.

Length 12-15 mm.

*Hab.* Adelaide, S. Australia; Ararat and Ringwood, Victoria.

### 37. ANTHOBOSCA NIGRA Sm.

*Anthobosca nigra* Sm. Cat. Hym. B. M. vii. p. 59 (1859), ♂.

*Thynnus reischii* D. T. Cat. Hymen. viii. p. 114 (1897), ♂.

♂. Clypeus truncate at the apex; antennæ nearly as long as the thorax and median segment combined. Pronotum short, scarcely more than half as long as the scutellum, very slightly narrowed anteriorly. First dorsal segment longer than the apical breadth; seventh dorsal segment broadly rounded at the apex. Hind tibiæ rather feebly serrate; hind femora without a lobe at the apex beneath. Second abscissa of the radius longer than the first, the two combined much shorter than the third; first transverse cubital nervure oblique, sharply bent close to the cubitus; first recurrent nervure received at the middle of the second cubital cell, second at two-fifths from the base of the third cubital cell. The distance between the cubitus of the hind wing and the transverse median nervure is greater than half the length of that nervure.

Black; the fore tibiæ ferruginous within; calcaria whitish. Wings hyaline, nervures fuscous.

Length 9-12 mm.

*Hab.* Victoria and South Australia.

Differs from *varipes* in the absence of a carina on the scutellum, in the colour of the legs, and the more distinct serration of the hind tibiæ.

### 38. ANTHOBOSCA ÆTHIOPS Sm.

*Anthobosca æthiops* Sm. Descr. new spec. Hymen. p. 175 (1879), ♂.

*Thynnus stolzii* D. T. Catal. Hymen. viii. p. 116 (1897), ♂.

♂. Antennæ stouter than in other Australian species; pronotum very slightly narrowed anteriorly, shorter than the scutellum. Head and thorax very closely and finely punctured, median segment transversely rugulose, short and not as strongly convex as in other species. First dorsal segment very little longer than the apical breadth; seventh dorsal segment narrowly

truncate at the apex. Hind tibiae spinose; hind femora without a rounded lobe at the apex beneath. Second abscissa of the radius equal to the first, the two combined shorter than the third; first transverse cubital nervure oblique, sharply bent close to the cubitus; first recurrent nervure received close to the middle of the second cubital cell, second just before one-third from the apex of the third cubital cell. Cubitus of the hind wing separated from the transverse median nervure by a distance equal to one-third of the length of that nervure.

Black; the inner margin of the eyes narrowly whitish; calcaria whitish; wings hyaline, tinged with fuscous, nervures fuscous.

Length 14 mm.

*Hab.* Champion Bay, W. Australia.

39. *ANTHOBOSCA MODERATA* Turn. (Pl. LXXXI. fig. 4.)

*Anthobosca moderata* Turn. Ann. & Mag. Nat. Hist. (8) iii. p. 482 (1909), ♂.

♂. A minute tubercle in the middle of the clypeus; pronotum not much narrowed anteriorly, not more than half as long as the scutellum; first dorsal segment a little narrower at the apex than long, a little longer than the second segment. Hind tibiae very distinctly spinose; hind femora with a very distinct rounded lobe at the apex beneath. Second abscissa of the radius longer than the first, the two combined about equal to the third; first recurrent nervure received at the middle of the second cubital cell, second beyond one-third from the base of the third cubital cell. Cubitus of the hind wing originating just before the transverse median nervure.

Black; mandibles at the base, clypeus, posterior margin of pronotum, tegulae, a spot on the mesonotum, postscutellum, a spot on each side at the apex of the median segment, a small lateral spot on each side of dorsal segments 1-5, a large spot on each side of the seventh segment, the base of the tibiae and the base of the tarsi whitish yellow; the apex of the seventh dorsal segment testaceous. Wings hyaline, tinged with fuscous; nervures fuscous.

Length 12 mm.

*Hab.* Townsville, Queensland.

40. *ANTHOBOSCA FRENCHI* Turn.

*Anthobosca frenchi* Turn. Proc. Linn. Soc. N.S.W. xxxii. p. 518 (1907), ♂.

♂. Clypeus truncate at the apex; pronotum much shorter than the scutellum, very slightly narrowed anteriorly. First dorsal segment no longer than the apical breadth; seventh dorsal segment broadly rounded at the apex. Hind tibiae very feebly serrate; hind femora without a lobe at the apex beneath. Second abscissa of the radius longer than the first, the two

combined as long as the third; first transverse cubital nervure oblique, strongly bent near the cubitus, longer than the second; first recurrent nervure received at the middle of the second cubital cell, second at one-third from the apex of the third cubital cell; the distance between the cubitus of the hind wing and the transverse median nervure equal to less than half the length of that nervure.

Black; base of the mandibles, a small spot round the base of each antenna, the hind margin of the pronotum very narrowly, tegulae, anterior tibiae in front, and the base of the hind tibiae pale yellow; apex of the mandibles and fore tarsi fusco-ferruginous. Wings hyaline, nervures dark fuscous.

Length 7-8 mm.

*Hab.* Victoria.

#### 41. ANTHOBOSCA LAGARDEI Turn.

*Anthobosca lagardei* Turn. Trans. Ent. Soc. London (1908), p. 86, ♂.

♂. Differs from *A. frenchi* in the yellow clypeus, yellow spot on the mesonotum, postscutellum, apex of median segment, and on each side of the seventh dorsal segment; in the rounded lobe at the apex of the hind femora beneath, which is well developed in *lagardei*, and in the yellow basal joints of the tarsi.

Length 8 mm.

*Hab.* Sydney, New South Wales.

#### 42. ANTHOBOSCA LONGIPALPA Turn.

*Anthobosca longipalpa* Turn. Proc. Linn. Soc. N.S.W. xxxii. p. 517 (1907), ♂.

♂. Clypeus very feebly emarginate at the apex; the apical joint of the maxillary palpi filiform, longer than the penultimate joint, the three apical joints much more slender than the basal ones. Pronotum short, very slightly narrowed anteriorly. First dorsal segment a little longer than the apical breadth; seventh dorsal segment narrowly truncate at the apex. Hind tibiae feebly spinose; the lobe at the apex of the hind femora beneath not distinct. Second abscissa of the radius nearly twice as long as the first, the two combined longer than the third. First transverse cubital nervure curved, much longer than the second, and rather sharply bent near the cubitus; recurrent nervures received a little before the middle of the second and third cubital cells. Cubitus of the hind wing originating before the transverse median nervure, the distance between it and that nervure equal to about one-third of the length of the transverse median nervure.

Black; posterior margin of the pronotum very narrowly, a transverse line on the postscutellum, a spot on each side of the seventh dorsal segment, and the base of the hind tibiae whitish



yellow; tibiæ fusco-ferruginous; calcaria white. Wings hyaline, nervures fuscous.

Length 12 mm.

*Hab.* Cairns, Queensland.

43. *ANTHOBOSCA CRASSICORNIS* Sm. (Pl. LXXXI. fig. 1.)

*Tachypterus crassicornis* Sm. Cat. Hym. B. M. vii. p. 64 (1859), ♂.

*Trachypterus crassicornis* D. T. Cat. Hymen. viii. p. 120 (1897), ♂.

*Anthobosca crassicornis* Turn. Proc. Linn. Soc. N.S.W. xxxii. p. 519 (1907), ♂.

♂. Clypeus produced in the middle and rather narrowly truncate at the apex. Antennæ slightly longer than the thorax and median segment combined. Head and thorax very closely and not very finely punctured. First abdominal segment scarcely longer than the second; the apex of the dorsal segment rounded and a little, but not very distinctly, narrower than the first segment is long. Posterior tibiæ very distinctly serrate, tarsal unguis bifid. Second abscissa of the radius longer than the third; both recurrent nervures received by the second cubital cell, the first at two-fifths from the base, the second at about nine-tenths or more from the base. Third cubital cell as long on the radius as on the cubitus.

Black, with long grey pubescence; mandibles, clypeus, lower portion of the inner margin of the eyes, anterior coxæ, trochanters and femora beneath, and a line beneath the intermediate femora yellow; second and third abdominal segments and the base of the fourth, tibiæ, tarsi, hind femora, and intermediate femora above ferruginous. Wings hyaline, nervures fusco-ferruginous, stigma fuscous.

Length 13 mm.

*Hab.* Australia.

A variety has the ferruginous colour much obscured. As mentioned under that species, I believe this to be the male of *A. clypeata* Sm, owing to the similarity of the structure of the tarsal unguis, the position of the recurrent nervures, the length of the second abscissa of the radius, and some similarity of colour.

44. *ANTHOBOSCA ERRANS* Sm.

*Anthobosca errans* Sm. Descr. new spec. Hymen. p. 174 (1879), ♂.

♂. Clypeus broadly truncate at the apex, not toothed; antennæ short and stout. Pronotum shorter than the scutellum, distinctly narrowed anteriorly; scutellum and median segment obscurely longitudinally carinated in the middle. First dorsal segment longer than the apical breadth; seventh dorsal segment

narrowly truncate at the apex. Hind tibiae serrate; hind femora with a rounded lobe at the apex beneath. Second abscissa of the radius nearly twice as long as the first, the two combined shorter than the third; first transverse cubital nervure oblique, strongly bent close to the cubitus, longer than the second; the distance between the cubitus of the hind wing and the transverse median nervure equal to about one-third of the length of that nervure. Tarsal unguis bifid.

Black; base of the mandibles, clypeus, a spot on each side of the pronotum, a spot on the mesonotum, one on the scutellum and a transverse line on the postscutellum yellow; legs ferruginous. Wings hyaline, nervures fusco-ferruginous.

Length 13 mm.

*Hab.* Zululand.

#### 45. ANTHOBOSCA FLAVOPICTA Turn.

*Anthobosca flavopicta* Turn. Trans. Ent. Soc. London, p. 399 (1910), ♂ pl. L. fig. 4.

♂. Clypeus subtruncate at the apex, not toothed. Posterior tibiae serrate, tarsal unguis bifid.

Black; clypeus with a black spot in the middle, inner margin of the eyes narrowly, a small spot behind the eyes near the summit, a broad band on the posterior margin of the pronotum, tegulae, a large spot on the scutellum, one on the postscutellum, the apex of the fore femora, and the anterior and intermediate tibiae and tarsi above pale yellow; tibiae and tarsi ferruginous brown. Wings hyaline, nervures black.

Length 11 mm.

*Hab.* Zanzibar.

#### 46. ANTHOBOSCA BIDENTATA Cam.

*Odontothynnus bidentatus* Cam. Rec. Albany Mus. i. p. 162 (1904), ♂.

♂. Apex of clypeus bidentate. Hind tibiae serrate. First transverse cubital nervure rounded. Wings hyaline, the apical half fusco-violaceous.

Black; lower half of inner orbits of the eyes, face, clypeus, base of mandibles, base and outer side of fore and intermediate tibiae, calcaria, tarsi, base of hind tibiae, and the posterior margin of the pronotum broadly yellow.

Length 11-12 mm.

*Hab.* Grahamstown, S. Africa.

#### 47. ANTHOBOSCA LACTEIPENNIS Cam.

*Odontothynnus lacteipennis* Cam. Rec. Albany Mus. i. p. 162 (1904), ♂.

♂. Apex of clypeus bidentate. Hind tibiae serrate. First

transverse cubital nervure oblique. Wings hyaline, nervures white.

Colours as in *bidentata*.

Length 10 mm.

*Hab.* Grahamstown, S. Africa.

I have seen neither *bidentata* nor *lacteipennis*. Cameron's statement that the unguis of the hind tarsi are simple, not bifid, needs confirmation.

#### 48. ANTHOBOSCA BIPUSTULATA Turn.

*Anthobosca bipustulata* Turn. Ann. & Mag. Nat. Hist. (8) iv. p. 343 (1909), ♂.

♂. Slender; antennæ stout, tapering towards the apex; pronotum scarcely more than half as long as the scutellum, moderately narrowed anteriorly. First dorsal segment nearly half as long again as the apical breadth; seventh dorsal segment rather narrowly rounded at the apex. Tarsal unguis bifid; hind tibiae serrate; hind femora without a distinct lobe at the apex beneath. Apical joint of maxillary palpi filiform. Second abscissa of the radius twice as long as the first, the two combined nearly as long as the third; first transverse cubital nervure oblique, sharply bent near the cubitus, longer than the second; the distance between the cubitus of the hind wing and the transverse median nervure equal to half the length of that nervure.

Black; mandibles, clypeus, scape beneath, a spot on each side on the posterior margin of the pronotum, the base of the tegulae, a small spot on the mesonotum, one on the scutellum, another on the postscutellum, the two latter spots sometimes absent, and the anterior coxae beneath yellow; legs ferruginous. Wings hyaline, nervures fuscous.

Length 8-12 mm.

*Hab.* Barbacena, Minas Geraes.

A variety has the legs black, marked with yellow.

### EXPLANATION OF THE PLATES.

#### PLATE LXXXI.

- |  |  |
|--|--|
| Fig.   | Fig.   |
| 1. <i>Antholosea crassicornis</i> Sm. ♂.     | 10. <i>Braunsomeria quadraticeps</i> Turn. ♀.    |
| 2. <i>Antholosea clypeata</i> Sm. ♀.         | 11. <i>Myzine stigma</i> Turn. ♂.                |
| 3. <i>Anthobosca fastuosa</i> Sm. ♀.         | 12. <i>Elis (Mesa) aliciae</i> Turn. ♀.          |
| 4. <i>Anthobosca moderata</i> Turn. ♂.       | 13. <i>Elis (Mesa) longiventris</i> Turn. ♂.     |
| 5. <i>Anthobosca erythronota</i> Cam. ♂.     | 14. <i>Myzine braunsi</i> Turn. ♂.               |
| 6. <i>Anthobosca erythronota</i> Cam. ♀.     | 15. <i>Elis (Mesa) dimidiaticornis</i> Bingh. ♂. |
| 7. <i>Anthobosca albomaculata</i> Sm. ♂.     | 16. <i>Elis (Mesa) tricolor</i> Sm. ♀.           |
| 8. <i>Anthobosca albomaculata</i> Sm. ♀.     |  |
| 9. <i>Braunsomeria quadraticeps</i> Turn. ♂. |  |

## PLATE LXXXII.

## Neuration of Wings.

- |  |  |  |
|--|--|--|
| Fig.   |  | Fig.   |
| 1. <i>Anthobosca australis</i> Sichel. ♀.    |  | 9. <i>Elis (Mesa) ruficeps</i> Sm. ♀.        |
| 2. <i>Anthobosca australis</i> Sichel. ♂.    |  | 10. <i>Elis (Mesa) ruficeps</i> Sm. ♂.       |
| 3. <i>Anthobosca anthracina</i> Sm. ♀.       |  | 11. <i>Elis (Mesa) tricolor</i> Sm. ♀.       |
| 4. <i>Anthobosca erythronota</i> Cam. ♀.     |  | 12. <i>Elis combusta</i> Sm. ♀.              |
| 5. <i>Anthobosca clypeata</i> Sm. ♀.         |  | 13. <i>Myzine stigma</i> Turn. ♂.            |
| 6. <i>Anthobosca insularis</i> Sm. ♀.        |  | 14. <i>Myzine braunsi</i> Turn. ♂.           |
| 7. <i>Braunsomeria quadraticeps</i> Turn. ♂. |  | 15. <i>Myzine constrictiventris</i> Turn. ♂. |
| 8. <i>Elis (Mesa) aliciae</i> Turn. ♀.       |  | 16. <i>Myzine abdominalis</i> Guér. ♀.       |

## PLATE LXXXIII.

## Exoskeletal Structures.

- Fig. 1. *Anthobosca australis* Sichel. ♀. Suture between two basal abdominal segments.
2. *Elis (Mesa) ruficeps* Sm. ♀. Suture between two basal abdominal segments.
3. *Anthobosca australis* Sichel. ♂. Apical ventral segment.
4. *Elis (Mesa) ruficeps* Sm. ♂. Apical dorsal segment.
5. *Myzine abdominalis* Guér. ♂.
6. *Anthobosca australis* Sichel. ♀. "Tarsul unguis."
7. *Anthobosca clypeata* Sm. ♀.
8. *Anthobosca insularis* Sm. ♀. "Intermediate" and hind coxae.
9. *Elis (Mesa) aliciae* Turn. ♀. Basal joint of hind tarsus.
10. *Elis (Mesa) ruficeps* Sm. ♀.
11. *Elis (Mesa) longiventris* Turn. ♂. Two "basal segments" of abdomen.
12. *Myzine constrictiventris* Turn. ♂. " " "
13. *Anthobosca australasie* Guér. ♂. " " "
14. *Anthobosca australis* Sichel. ♂. " " "
15. *Elis (Mesa) ruficeps* Sm. ♂. " " "
16. *Elis (Mesa) ruficeps* Sm. ♀. Intermediate and hind coxae. "

## 40. Notes on the Spanish Ibex.

By ABEL CHAPMAN, F.Z.S.

[Received April 13, 1912: Read May 7, 1912.]

## INDEX.

	Page
Distribution .....	755

In Professor Angel Cabrera's most informative paper on *Capra pyrenaica*,\* two small points occur to me as worthy of brief comment. In discussing the present distribution of the Spanish Wild-Goat in some six isolated colonies, Dr. Cabrera takes exception to the remark in 'Unexplored Spain' (by Walter Buck, C.M.Z.S., and myself) that they had been so isolated "during ages." Well, the term used in our former book ('Wild Spain') was "during centuries," and that is certainly more definitive and probably more accurate. Dr. Cabrera, however, goes on to state that there exist "strong reasons for believing that in the past

\* P. Z. S. 1911, p. 363.

[inferentially as late as the middle of the seventeenth century—say 250 years ago] Ibex inhabited every suitable point of almost every mountain-ridge in Spain.” The only reason actually adduced, however, is the prevalence of place-names based upon, or compounded with, the Spanish word *Cabra* = goat. Such names, it is true, are ubiquitous; but it would never have occurred to me that those names necessarily refer to the *wild* goat. Spain is a land of goats, and many localities bearing names such as Sierra de las Cabras, Cabrales, Cebrero, and so on, are not at all adapted to the nature and requirements of the wild Ibex. I would suggest that, in many cases, the names merely indicate the existence of suitable local pasturage for domestic goats, which are herded everywhere.

Again, Dr. Cabrera translates the Spanish name of the Ibex, *Cabra montés*, as equivalent to “Mountain-Goat.” Now it would be nothing less than presumptuous for me, a foreigner with but a limited colloquial knowledge of the Spanish tongue, to question his rendering. I do not do so. I accept that as the pure classic Castilian of Madrid. But I do venture to say that, in wilder Spain, the term *monte*, with its derivative adjective *montés* (pronounced *montéss*), possesses quite a different signification. *Monte* may occasionally, and in combination, be used to indicate a hill or mountain; but in its ordinary provincial sense, it signifies scrub or brushwood. Thus the wild-cat, which is equally common on lowland or sierra, is known as *Gato montés* = Scrub-Cat: on the low-lying plains of Andalucía or Estremadura, the expression *Reses monteses* includes all the scrub-haunting animals—such as deer, wild-boar, lynx, etc.

Now, viewed in this light, it has always appeared to me utterly inexplicable and incongruous to apply the name *Cabra montés*, or Scrub-Goat, to the Ibex of the higher ranges, such as the Sierras de Grédos and Nevada, where the Ibex live exclusively amidst rock-regions far above the topmost levels of scrub. But such incongruity would disappear if Dr. Cabrera's assumption were correct, that the Ibex, up to a couple of centuries ago, occupied the whole vast area shown in the map at p. 965, *suprà*. Was such the distribution, that name would become appropriate enough, since an immense proportion of the dotted area consists, not of high mountains at all, but of low scrub-clad hills. Such country might appear, to preconceived ideas, totally unsuitable for Ibex: but we have the fact before us (as fully explained in our books on Spain) that in several of the lower Mediterranean sierras (some of which are bush-clad to the summits) the local Ibex do to-day take kindly to a bush-haunting habit. Indeed, in such situations, it is obvious, they have no other option.

This latter point tends to support Dr. Cabrera's assumption, and equally, of course, undermines our own.

In our two books we had pointed out that the Ibex of the two extreme ends of Spain (*i. e.*, those of the Pyrenees and those of

the Mediterranean sierras) most nearly assimilated to each other in their more flattened and laterally compressed horns\*. It is gratifying to find that our rough field-observations are now corroborated by Dr. Cabrera's skilled investigation and careful cross-sections. But again, it appears anomalous—assuming that complete isolation only commenced some two centuries ago—that the central group (now honoured with subspecific rank as *C. p. victorie*) should have developed the greater difference.

The females and young males of the Spanish Ibex are devoid of the dark dorsal stripe, as is correctly shown in the plate in 'Unexplored Spain,' at p. 140. They are of a dun-brown, unicolorous in coat as the Spanish Red-Deer; but Dr. Cabrera is quite justified in criticizing the second plate (*op. cit.* p. 967), at p. 216. That slip should be debited, in the first instance, to the artist, Mr. E. Caldwell, but the fault is wholly mine, since I should have detected the mistake and had it corrected before passing the drawing for reproduction.

If permissible to express an opinion on the three beautiful plates given by Dr. Cabrera, I would say that *in life* the Spanish Ibex is rounder and bulkier in the barrel than can ever be gathered from museum specimens, since skins shrink.

In conclusion, may I express a fervent hope (since interest in her vanishing Ibex has been aroused in Spain) that further protection may be extended to the few surviving colonies? Within my own time, Ibex have been exterminated in several of their earlier haunts. To-day they are at their last gasp in the Pyrenees and in the Gerez (Portugal). Fortunately, in Grédos, Morena, and Bermeja, their future has been assured—though only at the eleventh hour. Can our Spanish friends not see to safeguarding the much-menaced remnant that yet survives on the main chain of Nevada?

\* Unfortunately, in 'Unexplored Spain,' in an effort to be concise, and to avoid repetition, we omitted the word "laterally"; but a reference to 'Wild Spain,' p. 120, makes our meaning clear.

41. The Local Races of Burchell's Zebra. By Major J. STEVENSON-HAMILTON, C.M.Z.S., Game Warden of the Transvaal.

[Received April 1, 1912: Read May 21, 1912.]

(Text-figures 102-106.)

INDEX.

	Page
Variation .....	757

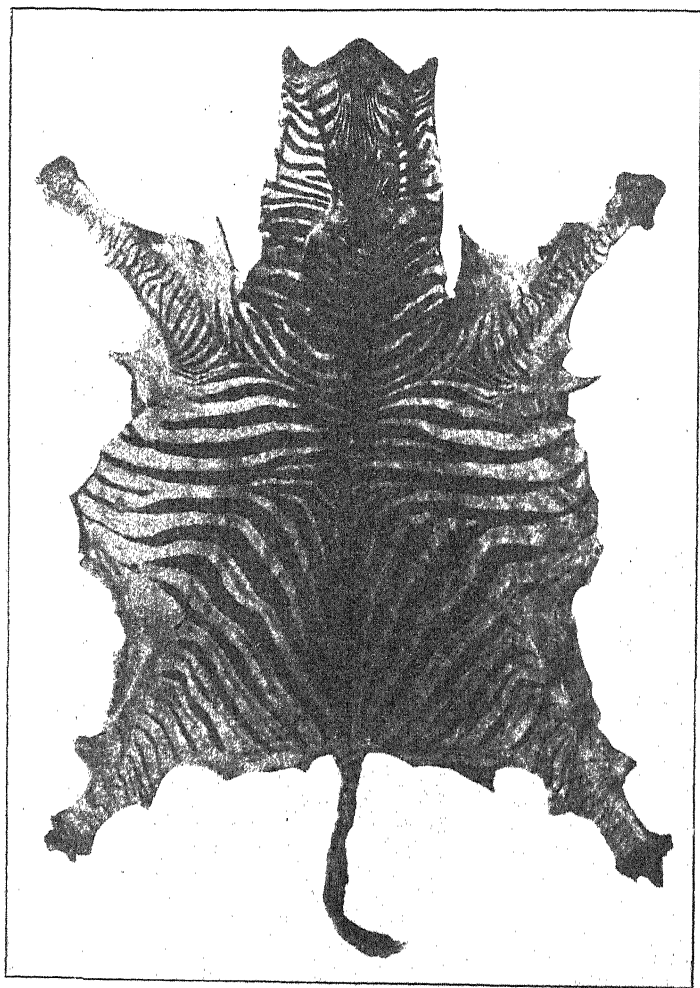
Burchell's Zebra (*Equus burchelli*) south of the Zambesi is usually divided by naturalists into several local races—*wahlbergi*, *transvaalensis*, *chapmanni*, *selousi*. These derive their subspecific distinctions from certain assumed differences in their leg and body striping as observed in museum specimens. Thus:—

"In *wahlbergi* the body stripes meet the ventral stripe inferiorly, while the legs are more or less fully striped; the shadow stripes on the hind quarters are strongly developed and not much narrower than the main stripes, which are narrower than the intervening spaces, while the fetlocks and pasterns are devoid of stripes and spots. A female zebra from the Transvaal differing from the typical *wahlbergi* by the extension of the shadow stripes to the neck, has been named *E. b. transvaalensis*. In *E. b. chapmanni* the shadow stripes have become faint and narrow, the legs are marked to the hoofs, but the stripes on the lower portions tend to break up into spots, and the inferior part of the pasterns is not wholly black. This race inhabits the country between Damaraland and Matabeleland. The last representative of the species with distinct shadow stripes is the Mashonaland bonte quagga (*E. b. selousi*), which differs from the last in that the striping of the legs is complete right down to the hoofs, the pasterns being striped on both sides, and their lower portion, owing to the fusion of several stripes, wholly black. The sides of the tail are also striped." (Lydekker.)

Long observation of the herds of Burchell's Zebra, running in the Transvaal Game Reserves, has convinced me that all or nearly all the above distinctions are found among them, frequently in the same herd. I have often discussed the matter with Dr. Gunning, of the Transvaal Museum, and have with him examined skins and live specimens obtained from the Western and Northern Transvaal. There is no doubt that any of these might, from their markings, have come from the Eastern part of the Province. Among the herds found in the latter occurs a very great variety of striping. Some animals show heavy, wide, and deeply tinted shadow stripes, while others display only the slightest indications of them. Some are strongly ringed down to the fetlocks, while others have no signs at all of any markings

below the knees and hocks. In some cases the body stripes are continued right round the barrel to the ventral stripe, in others

Text-fig. 102.



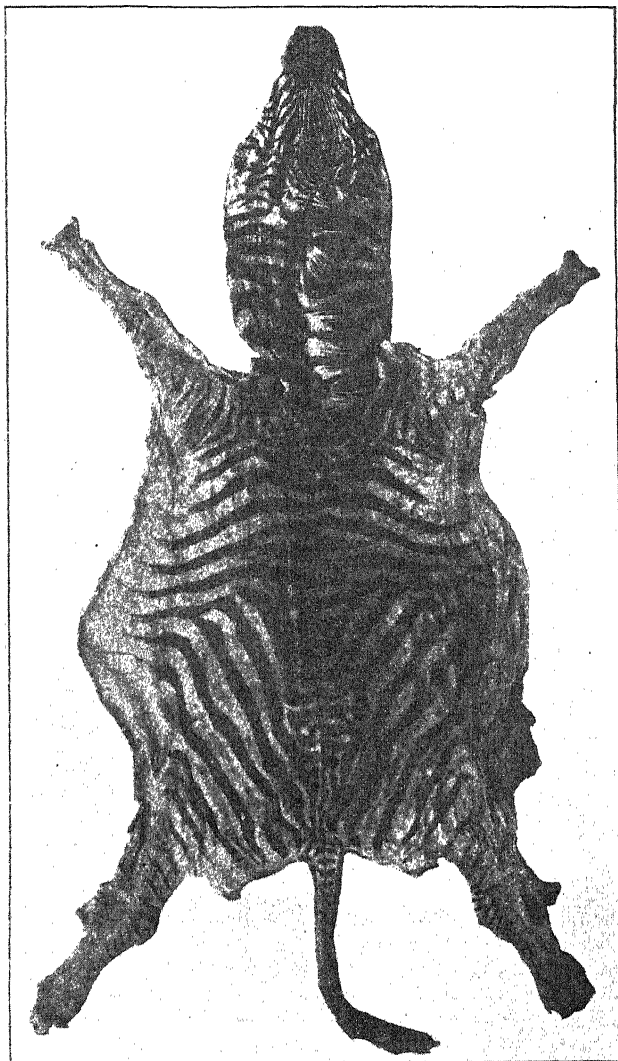
Burchell's Zebra, ♂, six years old, from south of the Sabi River,  
Eastern Transvaal.

they stop far short of it. The striping is usually carried right round the buttocks, but in I should say 20 per cent. at least of the



animals in each herd this is not the case. In fact there appears to be no special distinctive marking common to any locality or

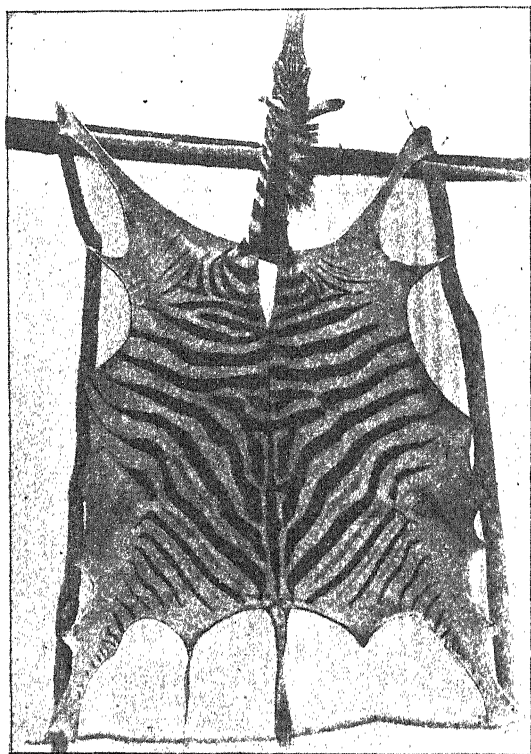
Text-fig. 103.



Burchell's Zebra, ♂, ten years old, from south of the Sabi River,  
Eastern Transvaal.

even herd. The shadow stripes on the neck, said to be distinctive of *E. b. transvaalensis*, have been occasionally, but very rarely, noticed in individuals, and I cannot conceive their presence to be more than an individual eccentricity, occasionally perhaps transmitted to offspring, but by no means constant.

Text-fig. 104.

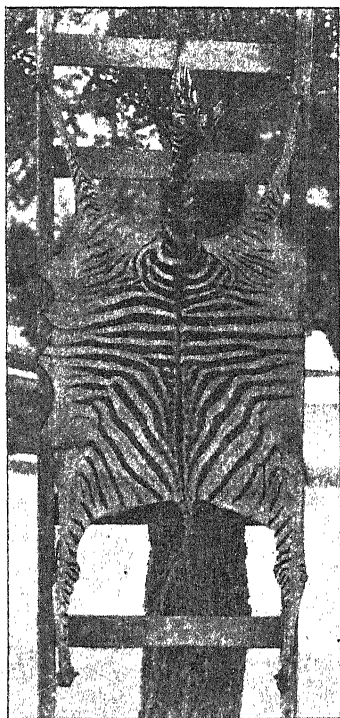


Burchell's Zebra, ♀, eight years old, from south of the Sabi River,  
Eastern Transvaal.

During the year 1911 I was asked to obtain a couple of skins for the Transvaal Museum, and selected two stallions from the same herd at a point a few miles south of the Sabi River (roughly 25 degrees S. lat. by 31 E. long.). I chose them merely as being typical of the darker and lighter forms of striping respectively, neither of them being in any way exceptional. Some animals present displayed deeper striping than the specimen shown in text-fig. 102, while others showed more white than that in text-fig. 103. These figures are from photographs of the skins. Text-

fig. 102 is that of a stallion six years old, and text-fig. 103 is of one about ten years of age. A little later I obtained the skins of a mare and her foal killed at a spot less than ten miles from where I had shot the two stallions. The photographs of these are reproduced as text-figs. 104 and 105.

Text-fig. 105.



Burchell's Zebra, ♂, foal, from south of the Sabi River, Eastern Transvaal.

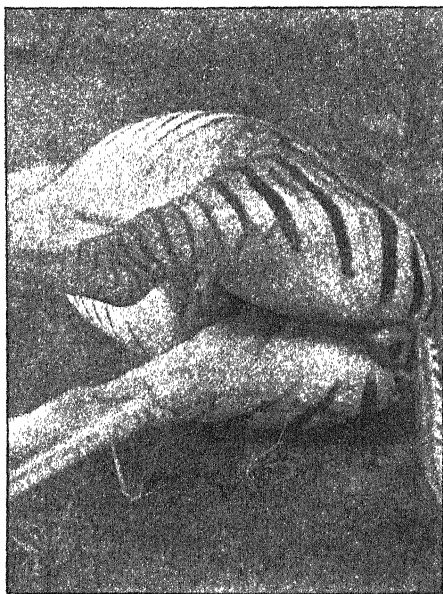
In the first stallion (text-fig. 102) both the ordinary and the shadow stripings are exceptionally strong, and the former is continued down and nearly all round the legs to the pasterns, which are quite black. The body stripes meet the ventral line throughout. The dorsal stripe is wide and very strongly marked. The neck stripes are exceptionally deep, and set very close together.

In the second stallion (text-fig. 103) the shadow striping is not nearly so well defined and the black stripes also are narrower. The body stripes do not extend all round the barrel, and there is practically no connection between them and the not very distinct

ventral stripe. The dorsal stripe is a very narrow black line, and there is a distinct gridiron pattern on the back. The legs are very slightly striped below the knees and hocks, and there are only a few black hairs on the pasterns.

In the case of the mare (text-fig. 104), while there is a well-marked ventral and a wide dorsal stripe, and complete union between the former and the barrel stripes, there is an entire absence of any black markings from all the pasterns, and from the fore legs below the knees.

Text-fig. 106.

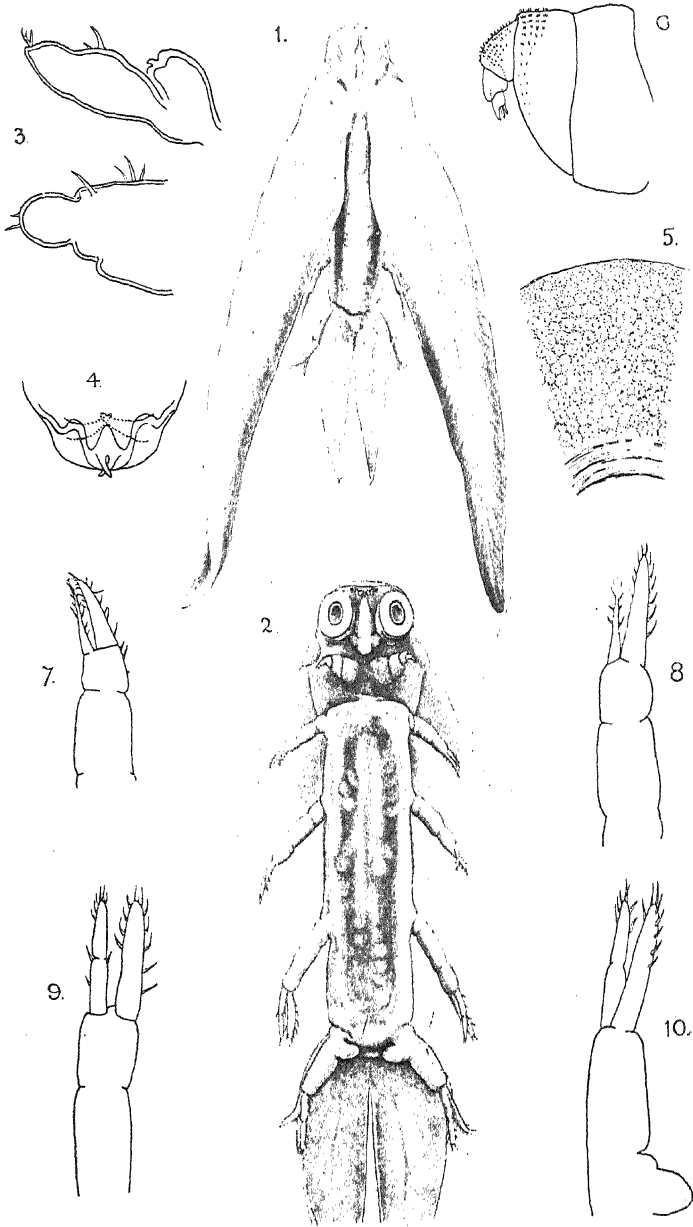


Burchell's Zebra, ♂ : the same animal as that shown in text-fig. 103, photographed just after death.

In the foal again (text-fig. 105), while the legs all bear faint indications only of stripes, the pasterns are all quite black, and there is some indication of a gridiron pattern on the back.

In none of the specimens is there the smallest indication of any shadow striping on the neck. It will be noticed also that in the younger stallion and the mare (text-figs. 102 & 104) the frontal stripes on the face run straight from forehead to nose, while in the older stallion (text-fig. 103) (and to some extent in the foal (text-fig. 105), though it does not show up well in the figure) the frontal stripes tend to form concentric rings.





G. M. Woodward, del.

Bale & Danielsson, Ltd. imp.

DIPTEROPELTIS HIRUNDO.

It would be interesting to know whether this absolute want of uniformity found among Burchell's Zebras in the Transvaal is peculiar to this country, or whether it is the case throughout Africa south of the Zambesi. Obviously it would be very dangerous to attempt any classification from isolated museum specimens obtained from the Transvaal at any rate.

Dr. Gunning proposes, I understand, to deal more fully in the forthcoming 'Annals' of the Transvaal Museum with a matter which I here only lightly touch upon.

## 42. On *Dipteropeltis* \*, a New Genus of the Crustacean Order Branchiura. By W. T. CALMAN, D.Sc., F.Z.S.†

[Received April 13, 1912: Read May 21, 1912.]

(Plate LXXXIV.‡)

INDEX.	
Structure or Morphology .....	Page 763
Ethology (Parasitism) .....	763
Geographical Zoology .....	763
Systematic: <i>Dipteropeltis hirundo</i> .....	763

The specimens described in this paper were presented to the British Museum twenty years ago by Spencer Moore, Esq., by whom they were collected in Southern Brazil. They were found among a number of specimens of *Dolops longicauda* Heller bearing the label "Parasite on the gills and body of the fish known all up the river as 'Dorado' from its golden colour. From Corumbá and neighbourhood, Matto Grosso."

### DIPTEROPELTIS HIRUNDO §. (Pl. LXXXIV. figs. 1, 2.)

Calman, Abstract P. Z. S. 1912, p. 34 (May 28th).

*Description of female*:—The most striking feature of the species is the form of the carapace, the lateral lobes of which are drawn out into narrow lanceolate wings directed backwards and extending far beyond the tips of the long abdominal lobes. The wings are fleshy in texture, traversed by numerous branching blood-channels, but without spines or other armature on the under surface.

The head is small, defined on each side from the carapace wings

\* The complete account of the new form described in this paper appears here, but since the name and a preliminary diagnosis were published in the 'Abstract,' it is distinguished by being underlined.—EDITOR.

† Published by permission of the Trustees of the British Museum.

‡ For explanation of the Plate see p. 766.

§ For definition of the genus see p. 766.

by a shallow antero-lateral sinus from which two converging grooves run in on the dorsal surface. These grooves unite into one on each side, but the resulting groove dies out before reaching the middle line. A pair of inter-ocular chitinous rods are well-marked, closely approximated in front, diverging posteriorly, and united by an indistinct articulation with a nearly parallel posterior pair. The paired eyes are very small and close together near the front margin. The unpaired eye could not be detected.

The free thoracic region is not distinctly segmented; it is of equal width throughout and more than three times as long as wide.

The abdominal lobes are very long, narrowly lanceolate, and cleft nearly to the base. No trace of furcal rami can be found.

The antennules and antennæ (fig. 3) are very minute and nearly hidden from view under the in-turned front margin of the head. The antennules, in particular, are very easily overlooked; they are not divided into segments but have a blunt lobe at the base carrying a short apical tooth. The antennæ are about the same length, and consist of a stout basal part and a subglobular terminal part separated from it by a constriction.

The mouth-parts form a prominent cone (fig. 4). The two large and well-separated lobes of the upper lip are unarmed. The lower lip bears a pair of slender conical papillæ ("maxillæ" of Claus) which project slightly from the opening of the mouth. The mandibles are crescentic in form, with the concave edge very finely serrated and the convex edge bearing a few teeth near the tip.

In front of the oral cone and continuous with it at the base is a papilla, directed forward, having at its tip the opening of a duct. This, no doubt, represents the sheath of the preoral "sting" of *Argulus*, but no trace of the spine or sting itself could be detected in the dissection of two specimens. At the base of this papilla and of the mouth-cone are groups of very large cells, presumably glandular, with deeply-staining nuclei.

The suckers (first maxillæ, second maxillæ, or first maxillipeds of various authors) are placed close together in front of the mouth-cone, generally concealing altogether the preoral papilla. In place of the usual radial supports, the whole of the membranous border of the sucker is covered with discoidal scales (fig. 5).

The maxillipeds (fig. 6) (maxillæ of some authors) are very short, very stout at the base, and tapering rapidly to the tip. They are each composed of five segments, of which the second and third have numerous pectinate or branched spines on the ventral and anterior surfaces. The terminal segment bears two minute claws and a process which lies alongside of them.

The successive pairs of legs (figs. 7-10) are set wide apart from each other along the sides of the thoracic region. The rami are in all cases shorter than the protopodite and carry only a few short setæ; there is no flagellum on any of the legs. In the first



pair the endopod may be a good deal shorter than the exopod, or, as in the specimen figured, nearly equal to it; both rami are unsegmented. In the second pair also the rami are unsegmented, and the endopod is from about one-half to two-thirds as long as the exopod. In the third and fourth pairs the rami are subequal and the endopod is divided into two subequal segments. The basal lobe of the protopodite in the fourth pair is tongue-shaped, with a slight protuberance at the base of its distal edge.

*Dimensions of Holotype in millimetres.*

Length of body to tip of abdominal lobes.....	20.0
Total length to tip of carapace wings .....	26.0
Breadth of head .....	2.5
Length of thoracic region .....	8.0
Breadth of thoracic region .....	2.5
Breadth of wing at base .....	1.8
Greatest breadth of wing, at about 8 mm. from base .....	4.8
Length of abdominal lobes.....	6.8
Greatest breadth of abdominal lobes.....	1.3
Length of antennules and antennæ, about .....	0.13
Length of oral cone.....	0.5
Greatest diameter of sucker .....	1.1
Length of second leg .....	1.8
Diameter of eyes, about .....	0.1
Distance apart of eyes, about.....	0.45

*Locality.*—Corumbá, on the Paraguay River, Matto Grosso, Brazil. Four female specimens taken (in company with *Dolops longicauda*) on the fish known as “Dorado” (probably a species of *Salminus*).

*Holotype.*—Female, No. 92.10.24.2 in British Museum Register of Crustacea.

*Affinities.*—In having the so-called maxillæ or first maxillipeds modified into suckers this species differs from the genus *Dolops*, and in possessing antennules and a preoral papilla it differs from *Chonopeltis*. From all the species hitherto referred to *Argulus* it differs in (1) the remarkable form of the lateral wings of the carapace; (2) the length of the abdominal lobes and the absence of furcal rami, in which characters it resembles some species of *Dolops*; (3) the entire absence of conspicuous spines or hooks on the under side of the body and appendages, in which it resembles *Chonopeltis*; (4) the vestigial condition of antennules and antennæ; (5) the absence of a spine or sting on the preoral papilla; (6) the absence of the usual radial supports on the disc of the suckers. Some of these characters, especially Nos. 1, 3, and 6, are possibly not of great systematic importance, but together they seem to show that the new form is less closely related to any of the species included in the genus *Argulus* than

these are to one another. I have proposed, therefore, to establish for it a new genus, which may be defined as follows:—

#### DIPTEROPELTIS.

Calman, Abstract P. Z. S. 1912, p. 34 (May 28th).

Argulidæ with the so-called maxillæ modified as suckers; with the preoral papilla present, but without a spine; with antennules and antennæ very minute, imperfectly segmented; without large spines or hooks on under side of carapace, body, or appendages; without furcal rami on the abdominal lobes; with the lateral wings of the carapace greatly elongated.

Genotype.—*D. hirundo* Calman.

It is to be noted that the single species of *Chonopeltis*, *C. inermis* Thiele\*, is known only from a single specimen (from Lake Nyasa). It is not at all impossible, therefore, that the antennules, if they are as small as in *Dipteropeltis*, may have escaped observation, and it is even possible, though less probable, that an unarmed preoral papilla may be present. Should this prove to be the case it is doubtful whether, in spite of the great difference in the form of the carapace, the separation of *Dipteropeltis* from *Chonopeltis* could be maintained.

#### EXPLANATION OF PLATE LXXXIV.

(The magnifications given are only approximate.)

- Fig. 1. *Dipteropeltis hirundo*. Female (holotype), from the dorsal side.  $\times 3$ .  
 2. Anterior part of body of same specimen from ventral side. The suckers have been drawn apart and slightly backwards. In the preserved specimens they meet in the middle line and entirely conceal the preoral papilla.  $\times 6$ .  
 3. Antennule and antenna.  $\times 450$ .  
 4. Tip of oral cone from antero-ventral aspect.  $\times 100$ .  
 5. Part of membranous margin of one of the suckers.  $\times 160$ .  
 6. Maxilliped.  $\times 20$ .  
 7. Leg of first pair.  $\times 20$ .  
 8. Leg of second pair.  $\times 20$ .  
 9. Leg of third pair.  $\times 20$ .  
 10. Leg of fourth pair.  $\times 20$ .

Figures 3-10 are drawn from one of the paratypes.

\* Thiele, Zool. Anz. xxiii. p. 47 (1900); Mitth. Zool. Mus. Berlin, ii. p. 44, figs. 110-116 (1901).

43. On two new Larval Trematodes from the Striped Snake (*Tropidonotus ordinatus sirtalis*). By WILLIAM NICOLL, D.Sc., F.Z.S., Lister Institute of Preventive Medicine, London.

[Received April 9, 1912: Read May 21, 1912.]

(Text-figure 107.)

# INDEX.

	Page
Ethology: Two larval Trematodes in the mesenteric fat of Striped Snake ( <i>Tropidonotus ordinatus sirtalis</i> ). Adult form probably in a bird .....	767
Geographical Zoology: North America; Striped Snake infected with two larval Trematodes .....	767
Systematic: <i>Cercaria ordinata</i> , sp. n., and <i>Diplostomum sirtale</i> , sp. n., from cysts in the mesentery of the Striped Snake .....	768

The occurrence of encysted larval parasites in snakes is evidence, if such were wanting, that some snakes are eaten by other animals. What is more important, the character of the parasites may indicate what variety of animal is in the habit of eating the snake in question. Conversely, the presence of any particular species of adult parasite in an animal is almost always a sure proof that such animal eats the snake in which the larval stage is found. It is unfortunately in many cases a matter of difficulty to diagnose the systematic characters of a larval parasite. In a number of cases, however, it is possible to assign it to a definite genus, rarely to a particular species.

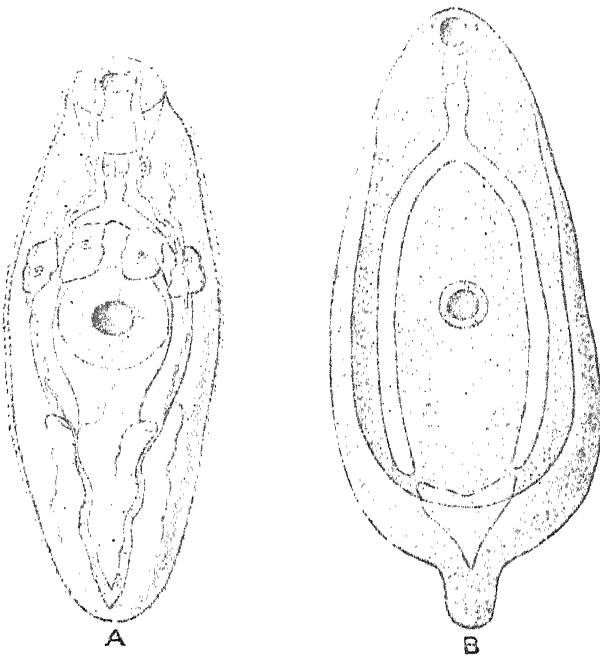
The two cases to be dealt with here present a certain amount of difficulty. The first larva is evidently a Distomate Trematode, but beyond that it is impossible to go; the second larva is just as obviously a Holostomid, and almost certainly belongs to the genus *Hemistomum*. Such a diagnosis does not lead very far, but it at least enables one to say that in all probability the Striped Snake (*Tropidonotus ordinatus*, var. *sirtalis*) is eaten by some bird, for adult Holostomata are known to occur only in birds. This will possibly be confirmed by direct observation.

Both forms were met with together in each of three Striped Snakes from North America, which died in the Society's Gardens on the 5th and 20th December, 1910, and on 10th March, 1911. They occurred in enormous numbers in the mesenteric fat along the whole length of the intestine. Each was enclosed in a small spherical or ovoid cyst with unusually thin and soft walls. Unlike what is generally found in a Trematode cyst, the wall gave the impression of being a thin membrane instead of the more usual tough chitinous investment. On this account, not only could the larvæ be extracted from the cysts without difficulty, but when placed in water they escaped readily of their own accord. When a piece of the cyst-infested mesentery was

suspended in water, a continuous shower of larvæ was observed to fall to the bottom of the vessel.

The first form, which I name *CERCARIA ORDINATA*, sp. n. (text-fig. 107 A), was much more numerous than the other. It is a typical tailless encysted cercaria, about  $\cdot 5$  mm. ( $\cdot 4$ – $\cdot 55$  mm.) in length and  $\cdot 2$ – $\cdot 25$  mm. in greatest breadth. In shape it is ovoid and flattened dorso-ventrally. The entire surface of the body is covered with minute regularly-arranged spines. The oral sucker is almost terminal and has a diameter of  $\cdot 07$  mm. ( $\cdot 06$ – $\cdot 08$  mm.).

Text-fig. 107.



A. *Cercaria ordinata*, sp. n. Ventral view,  $\times 150$ .

B. *Diplostomum sirtale*, sp. n. Ventral view,  $\times 150$ .

The length is usually slightly greater than the breadth, and the sucker has a somewhat characteristic funnel-shaped appearance. The globular ventral sucker is situated rather in front of the centre of the body, and has a diameter of  $\cdot 083$  mm. ( $\cdot 075$ – $\cdot 097$  mm.). Its distance from the anterior end of the body is on an average  $\cdot 22$  mm. ( $\cdot 17$ – $\cdot 25$  mm.). On the dorsal lip of the oral sucker are the two symmetrical apertures of the cystogenous ducts. The cystogenous glands are conspicuous structures, and consist of four

large cells situated in a transverse row immediately in front of the ventral sucker. There are two pairs, a right and a left. The ducts from each pair unite almost at once, and the united ducts then pass forward in an irregular course; but just before they reach the oral sucker each makes a characteristic twist, following which there is a gradual increase in calibre until near the termination, when they contract slightly again. The cystogenous glands have an irregular rectangular outline, and measure  $.048 \times .037$  mm. In direct contact with the oral sucker is the small muscular pharynx measuring  $.024$  mm., which is continued by a short, somewhat dilated oesophagus of the same length as the pharynx. The intestinal bifurcation is about midway between the two suckers. The diverticula are simple, somewhat wide tubes, which terminate not far behind the ventral sucker (*i. e.* a third of the distance from the sucker to the posterior end of the body). The excretory vesicle is V-shaped. A common trunk is practically absent, and the limbs extend forward to near the terminations of the intestinal diverticula. The excretory tubules are very fine; the main tube on each side extends forward to near the oral sucker, where it turns back. The excretory aperture appears to be slightly dorsal.

No trace of other organs could be made out, so that no accurate idea can be obtained of the systematic position of this larva. The peculiar configuration of the excretory vesicle may, in conjunction with the shape of the alimentary canal, eventually lead to the identification of its adult form, but at present, so far as I am aware, there is no known adult Distome to which this larva can be ascribed.

The second form, which I name *DIPLOSTOMUM SIRTALIS*, sp. n. (text-fig. 107 B), differs markedly from the first. It is about the same size, and occurs in somewhat similar cysts, but its shape and colour are entirely different. The body of *Cercaria ordinata* is light and transparent, whereas that of *Diplostomum sirtalis* is dark and almost opaque. The opacity is due to the presence of innumerable small granules distributed throughout the whole body. The shape is that of a typical *Diplostomum* larva, being scoop-like with a short handle. The shape is due to the rolling over of the postero-lateral margins of the body. In life, however, these margins are capable of more or less eversion, so that on occasion the body may appear almost flat. The dimensions of this larva are  $.48-.55 \times .28-.32$  mm., the short stumpy tail being  $.06$  mm. long.

The oral sucker measures  $.039$  mm. in diameter; the ventral sucker  $.042-.045$  mm. The latter is situated a little in front of the middle of the body,  $.25-.28$  mm. from the anterior end. Midway between it and the posterior end of the body occurs the characteristic Holostomid fixing disc, which appears as a transparent disc about the same size as the ventral sucker. Of the internal organs only the alimentary canal and excretory vesicle were visible. The former comprises a pharynx contiguous

with the oral sucker and measuring  $\cdot 024 \times \cdot 020$  mm. This is followed by an œsophagus about twice as long as the pharynx. The intestinal bifurcation takes place rather nearer the ventral sucker than the oral sucker, and the simple diverticula extend a little beyond the posterior border of the fixing disc. The excretory vesicle consists of a wedge-shaped sac, which extends forward as far as the ends of the intestinal diverticula.

This is in all probability the larval stage of some species of *Hemistomum*, parasitic in a bird.

44. A Note on the rare British Nudibranch *Hancockia eudactylota* Gosse. By Sir CHARLES ELIOT, K.C.M.G., C.B., F.Z.S.

[Received April 18, 1912: Read May 21, 1912.]

(Plate LXXXV.)

See Gosse, On *Hancockia eudactylota*, Ann. Mag. Nat. Hist. ser. 4, xx. 1877, pp. 316–318; Gamble, On two rare British Nudibranchs, *Lomanotus genei* and *Hancockia eudactylota*, *ib.* ser. 6, ix. 1892, pp. 378–385; Trinchese, Ricerche anatom. sul genere *Gorgia* (= *Hancockia*), Mem. della R. Accad. delle Sci. dell' Istituto di Bologna, ser. 5, vii. pp. 183–191, 1886; Eliot, Supplement to Alder and Hancock's Monograph of the British Nudibranchiate Mollusca, Ray Society, 1910, pp. 17, 72, 118–120, 163.

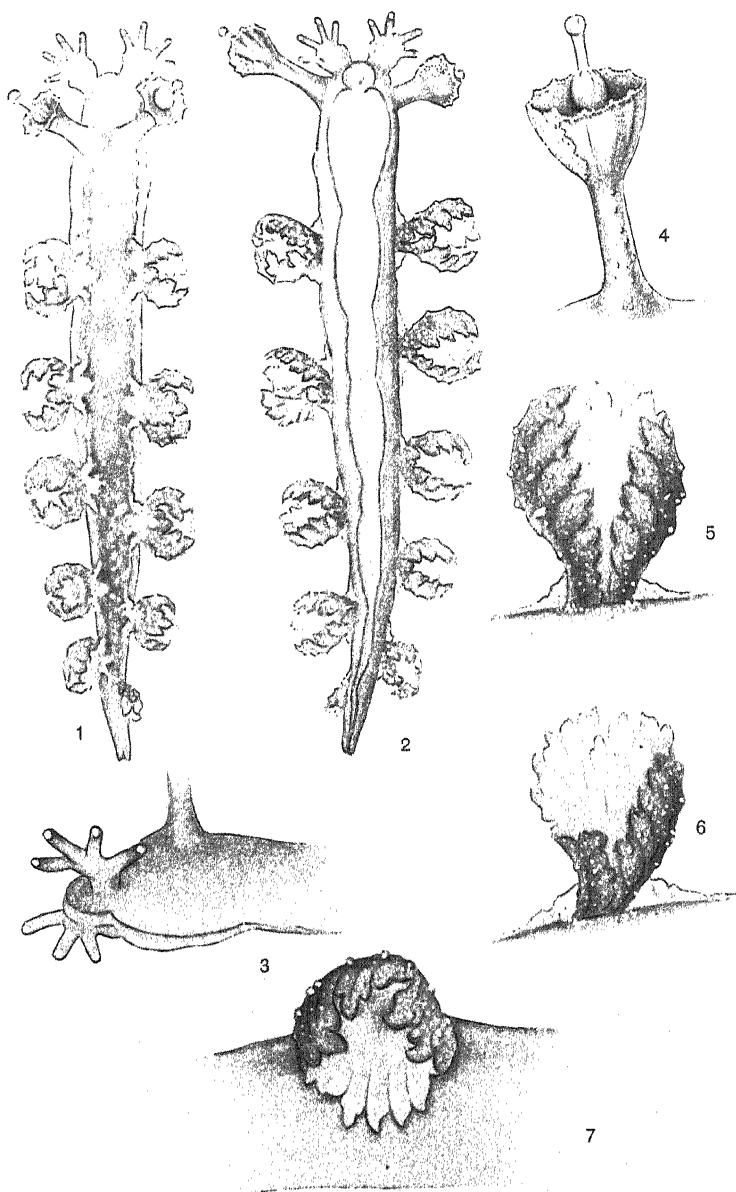
No coloured figure of this rare British Nudibranch has yet been published so far as I am aware. I endeavoured to include one in my Supplement to Alder & Hancock's Monograph, but no specimen of the animal could be obtained before the time fixed for publication. Shortly afterwards a single individual was captured at Plymouth and drawn by a local artist under the supervision of the naturalists who were working in the Laboratory of the Marine Biological Association. I have not seen the animal alive, but these drawings agree with what is known of its structure, and I have no doubt that they faithfully reproduce its appearance.

For an account of the genus and species see the references to my Supplement given above.

EXPLANATION OF PLATE LXXXV.

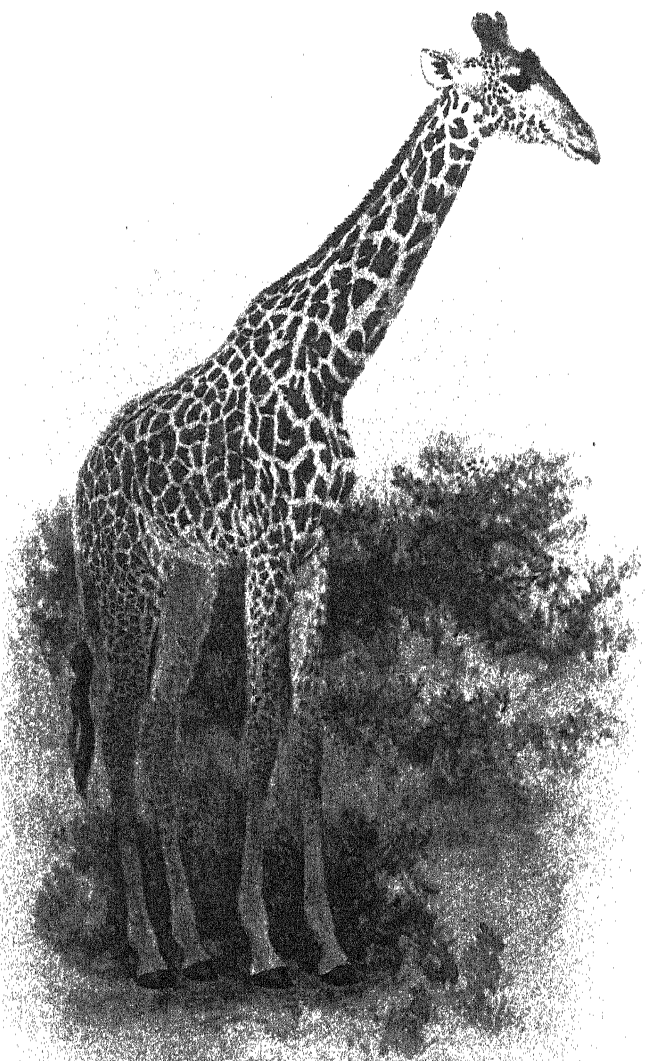
*Hancockia eudactylota*.

- Fig. 1. Dorsal view of animal.
- 2. Ventral view of animal.
- 3. Side view of head.
- 4. A rhinophore.
- 5. )
- 6. ) Different views of lateral processes.
- 7. )



London Stereoscope Co. Imp.

HANCOCKIA EUDACTYLOTA.



London Stereoscopic Co. Imp.

GIRAFFA CAMELOPARDALIS THORNICROFTI.



45. The North Rhodesian Giraffe.  
By R. LYDEKKER, F.R.S., F.Z.S.\*

[Received April 25, 1912: Read June 4, 1912.]

(Plate LXXXVI. †)

INDEX.

	Page
Rhodesia, Giraffe of .....	771
<i>Giraffa camelopardalis thornicrofti</i> , Description of ...	771

On the 20th of October, 1910, the British Museum (Nat. Hist.) received from Mr. H. Thornicroft, Native Commissioner, Petauke, North-east Rhodesia, the skin, skull, and limb-bones of an adult male Giraffe shot by himself in that district. Mr. Thornicroft had previously called on me in London, and expressed his willingness to shoot and present to the Museum a Giraffe from the single herd in this part of Rhodesia, if the necessary permit could be obtained. This was in due course procured, and was followed, after an interval, by the arrival of the above-mentioned skin and bones.

The skin was soon afterwards set up by Rowland Ward Ltd., and the mounted specimen placed in the big case at the head of the staircase leading to the East Corridor of the Museum, alongside the male and female of the East African *Giraffa camelopardalis rothschildi*. As it is mounted with the neck bent, it is difficult to ascertain the exact height, but I estimate this at close on 18 feet, or possibly rather more.

When the specimen was installed in its case, it became essential that it should receive a distinctive name; and I accordingly communicated the following preliminary note to 'Nature' ‡:—

"This Giraffe is characterised by the low and conical frontal horn, the grey colour and scattered spotting of the sides of the face, the chestnut-brown forehead, deepening into black on the tips of the horns, the absence of a distinctly stellate pattern in the neck and body spots, which are light brown on a yellowish fawn ground, and the uniformly tawny colour of the lower portion of the limbs. This Giraffe, which I propose to call *Giraffa camelopardalis thornicrofti*, appears to be related to the Kilimanjaro *G. c. tippelskirchi*, but differs by the more compact frontal horn, the brown, in place of grey, forehead, and the uniformly fawn lower part of the legs, the latter being whitish in adult bulls [of *tippelskirchi*], but fawn and spotted in cows and young bulls."

The last statement rests on the authority of Messrs. M. de

\* Published by permission of the Trustees of the British Museum.

† For explanation of the Plate see p. 773.

‡ Vol. lxxxvii. p. 484 (1911).

Rothschild and H. Neuville\*, who state that in the East African Giraffe which they describe as *rothschildi*, but which—despite the locality whence it is stated to come—is certainly *tippelskirchi*, these age and sex differences are observable. I have, however, doubts whether they hold good in all cases; and it is still possible, in spite of what I have previously written, that there may be one form (*schillingsi*) in which the shanks of adult bulls are white and another (*tippelskirchi*) in which they are fawn and spotted†, and further, that these two types may intergrade.

That the nearest relative of the Rhodesian Giraffe is *G. c. tippelskirchi*, may be considered certain. Of the latter I have had for comparison the mounted head and neck of an adult male, a mounted immature female, and the mounted head and neck of a calf, as well as a coloured plate in Messrs. de Rothschild and Neuville's memoir‡.

Elaborating to a certain extent the foregoing brief diagnosis, attention may be directed to the fact that *tippelskirchi* and *thornicrofti* agree (and thereby differ markedly from *rothschildi*) in having the triangular space between the eye and the nostril devoid of spots. In the adult male of *tippelskirchi*, however, the ground-colour of the whole head is dirty greyish white, whereas in *thornicrofti* the forehead is chestnut or umber-brown, deepening into black at the tips of the horns, which are grey in the Kilimanjaro race.

In the Rhodesian Giraffe the spots on the region behind the eye and the side of the lower jaw are very faintly marked, and blackish grey in colour; whereas in the Kilimanjaro bull they are larger, more numerous, and chocolate-brown in colour, being deeper in tint than the neck-spots (this feature being also shown in the immature female and the calf).

In *thornicrofti* the spots on the neck are burnt-umber in colour and markedly elongated in form, with their terminal ends jagged. There are about eight of them in the longitudinal row which starts immediately in advance of the point of the shoulder. In *tippelskirchi* they are more numerous (ten or eleven in what appears to be the corresponding row), less elongated, and much more irregular in shape.

Compared with the young cow *tippelskirchi*, the spots on the body of *thornicrofti* are less numerous, more especially on the hind-quarters, while many of them are more deeply incised on one side, although they are less jagged in general contour. The spotting on the inner side of the thighs and of the upper part of the fore-legs is also much less pronounced. In the original description (which was drawn up when the specimen was in the basement of the Museum) it is stated that the shanks of the legs are uniformly fawn, but, as a matter of fact, they are

\* Ann. Sci. Nat., Zool. ser. 9, vol. xiii, pp. 124, 129 (1911).

† See Proc. Zool. Soc. 1904, vol. i. p. 219.

‡ Op. cit. pl. ii. fig. 1, lettered *G. c. rothschildi*.

rufous-fawn with very faint traces of spotting nearly down to the fetlocks; while from the latter to the hoofs they are dirty greyish white.

The foregoing evidence clearly establishes the right of the North Rhodesian Giraffe to rank as a distinct local race; and if it be true that the one herd is completely isolated, there is probably no intergradation with the Kilimanjaro race.

## EXPLANATION OF PLATE LXXXVI.

Adult bull of *Giraffa camelopardalis thornicrofti*.

46. On Antler-Growth in the Cervidæ, with special reference to *Elaphurus* and *Odocoileus* (*Dorcylaphus*). By R. I. Pocock, F.R.S., F.L.S., F.Z.S., Superintendent of the Gardens and Curator of Mammals.

[Received and Read June 4, 1912.]

(Text-figures 108-112.)

## INDEX.

	Page
Classifications of the Cervidæ .....	773
Mode of growth of Antlers in typical Old World Deer .....	775
Interpretation of the Antlers of <i>Elaphurus davidianus</i> .....	777
Interpretation of the Antlers of <i>Odocoileus</i> sp. incert. ....	780
Date of Antler-change in American and Old World Deer ...	783 (Note)

*Introduction.*

Most, if not all, the attempts that have hitherto been made to understand the antlers of Deer and arrive at correct conclusions regarding the homology of the tines have been based upon comparisons between the fully formed antlers of different species. This, in my opinion, is the reason why there has been failure in some cases to detect homologies which study of the growth of individual antlers reveals.

The importance of this question depends upon the circumstance that twenty years ago Mr. Gordon Cameron\* proposed a classification of the Cervidæ, based upon the antlers, as a substitute for the classification, founded upon the skeletal structure of the fore feet, which Sir Victor Brooke had suggested†.

To make clear the purpose of the present paper, it is necessary to summarise briefly the rival classifications put forward by these two authors. Sir Victor Brooke divided the Cervidæ into two

\* 'The Field,' 1892, pp. 265, 703, 741, 860.

† P. Z. S. 1878, pp. 883-928.

sections. The first, which he called Telemetacarpia (Telemetacarpalia) because the distal ends of the lateral metacarpals persist, comprises the Roe (*Capreolus*), the Chinese Water-Deer (*Hydropotes*), the Reindeer (*Rangifer*), the Elk (*Alce*), and all the exclusively American deer with the single exception of the typical Wapiti (*Cervus canadensis*); the second, called Plesiometacarpia (Plesiometacarpalia) because the proximal ends of the lateral metacarpals are usually present, whereas their distal ends are suppressed, comprises all the deer of the Old World, except the four genera mentioned above, but none of those of the New World apart from the Wapiti. Amongst the Old World forms the most important species for the moment figuring amongst the Plesiometacarpalia is Père David's Chinese Deer (*Elaphurus davidianus*).

Mr. Cameron's classification was widely different. Dismissing as unimportant the character relied upon by Brooke, he divided the Cervidæ into three sections: one for the Reindeer with antlers in both sexes, the second for the Elk with laterally extended antlers, the third for the remaining species with antlers restricted to the male and erect or suberect. This third section, which alone concerns us now, was subdivided into two categories of species, one comprising those in which the antlers consist, as in the typical Old World deer and the Wapiti, of a "brow-tine" and a "beam," to use Gordon Cameron's terminology, and the other those in which the antler has, as he thinks, no brow-tine but consists of a "forked beam," as in all typical American deer (except the Wapiti) and in the Roe and Père David's Deer amongst the Old-World species.

Now with regard to the affinities of the species composing Cameron's third division, there is only one point in which there is complete divergence between him and Brooke. This concerns Père David's Deer, a species classified by Brooke with the Red Deer, Sambar, and other Elaphine stags, and by Cameron with the American forms allied to the Virginian and Mule Deer, the correct name of which seems to be *Odocoileus* \*.

So far as I can see, the only *à priori* objection to be raised against Mr. Cameron's system, if we accept his premises, is that it is based upon a secondary sexual character. But although it cannot be justifiably consigned to oblivion on that account, it may be doubted if it would ever have come into sufficient prominence for serious discussion had it not been for the unqualified acceptance accorded it by Mr. Lydekker. However that may be, it is clear that if Mr. Cameron's assumption that there is a fundamental difference in structure between the antlers of the groups of deer mentioned above is wrong, his classification, based on that claim, goes by the board.

In the following pages I shall endeavour to show that his classification is untenable, because a study of the seasonal growth

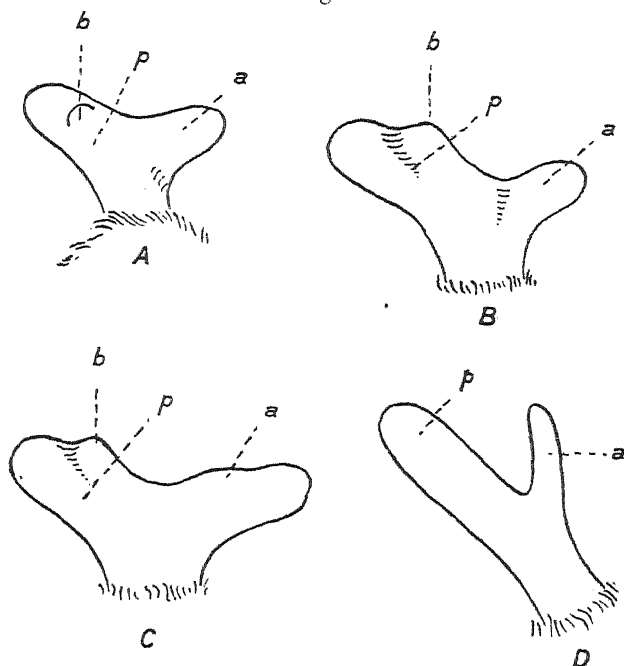
\* *Dorcelaphus* and *Cariacus* are better known but superseded terms.

of an antler of Père David's deer and of an American deer, allied to the Virginian, proves that the homologue of the brow-tine of the Elaphine stage is present in both—a conclusion which is by no means evident from an examination of the fully-formed antlers.

*Antler-Growth in typical Old-World Deer.*

In the Zoological Gardens I have repeatedly watched, year after year, the growth of the antlers of deer belonging to the Elaphine, Sikine, and Rusine types without finding any variation

Text-fig. 108.



Early growth-stages of Antlers of some Old-World Deer.

A & B. Successive stages observed in *Cervus hanglu*. C. *Cervus canadensis*.

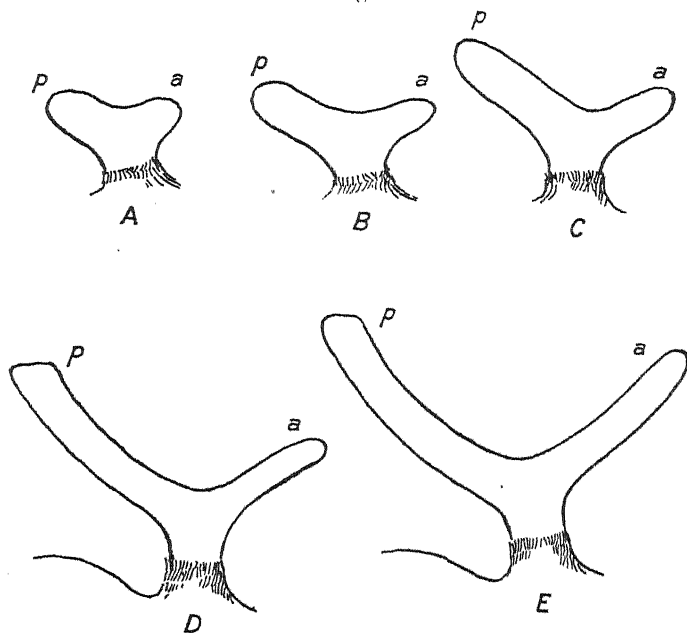
D. *Rusa aristotelis*.

a, the anterior branch or "brow-tine"; p, the posterior branch or "beam";  
b, the rudiment of the bez-tine arising from the posterior branch.

of moment in the method of their development. The antler starts as an undivided bud. This bud then shows signs of division into two buds, an anterior and a posterior. These buds

gradually, and with nearly equal rapidity, increase in length, the anterior growing forwards and the posterior backwards. In the Sambar (*Rusa*, text-fig. 108, *D*) and some other species they show a marked inclination upwards; so that at one stage the antler may be likened somewhat to a short-stalked Y, and at this or even at a later stage in deer like the Sambar (*Rusa*) and others which have no "bez"-tine, the antler may be indifferently described as an "unbranched beam with a brow-tine" or as a "forked beam" or as a biramous antler. The anterior and posterior branches sometimes, as in *Cervus eldi*, grow at approximately the same speed until the anterior has almost attained its limit; but usually the growth of the posterior tine is from the first more rapid. However that may be, the equivalence of the two branches in the early stages is plain enough; but afterwards this becomes less and less evident as the posterior branch continues to lengthen and develops its accessory tines.

Text-fig. 109.



Five stages (*A* to *E*) in the growth of an antler of *Rucervus duvaucelli*.

*a*, anterior branch or "brow-tine"; *p*, posterior branch or "beam."

These facts are shown in the annexed figure (text-fig. 109), representing five stages in the growth of an antler of a specimen of the Swamp Deer or Barasingha (*Rucervus duvaucelli*). These were

sketched on May 13, 16, 22, June 6 and 12. Similar stages may be observed in other typical deer of the Old World\*. In the Elaphine stags, however, which normally grow a "bez"-tine, the biramous stage is early complicated by the appearance of the bud of this tine. Now this tine has been regarded as a duplication of the brow-tine; and in Max Weber's† diagram showing suggested homologies of the tines in certain deer the brow- and bez-tines are tinted alike, suggesting his adoption of this view. Nevertheless I believe it to be quite incorrect, for in all cases where I have watched its origin, the bud of the "bez"-tine arises, not from the brow-tine at all, but from the "beam." It is, in fact, the basal or proximal tine of the posterior branch of the antler. This is illustrated in text-fig. 108, A-C, showing the early stages of the growing antler of the Hangul (*Cervus hanglu*) and of the Wapiti (*Cervus canadensis*).

*Antler-Growth in Père David's Deer (Elaphurus davidianus).*

There is no stag whose systematic position has troubled zoologists so much as *Elaphurus*. On the one side are those, like Dr. Gray, Mr. Cameron, and Mr. Lydekker, who, relying upon the structure of the antlers of the adult, placed the genus with the American deer. On the other side are those, like Sir Victor Brooke, Flower, Max Weber, and others, who, adopting the skeleton of the foot as a basis, classified it with the typical Old-World species.

The antlers of this stag have often been figured and described, and a good idea of their form in the adult may be gathered from text-fig. 110, C, and text-fig. 111, I. They typically consist of a comparatively long basal portion from which two branches arise: one long, slender, simple or divided, projects backwards parallel, or nearly so, with the animal's back; the other stout, erect, or curved slightly forwards, terminates in a pair of strong tines.

At first sight, these antlers appear to have no trace of a brow-tine. This was evidently Sir Victor Brooke's opinion, and it was adopted by Mr. Cameron and Mr. Lydekker, who, on the strength of this belief, boldly claimed that this stag belonged to the same group as the American deer, also held to have no brow-tine, despite the resemblances in other respects pointed out by Brooke between *Elaphurus* and the typical Cervidæ of the Old World. Prof. Garrod was more cautious, and frankly gave up the attempt to interpret the antlers of *Elaphurus* when he remarked that they "are at present quite beyond my comprehension."

This, then, was the state of the case when my researches on the specialised cutaneous glands of Ruminants‡ showed that the

\* Mr. J. G. Millais ('Mammals of Great Britain and Ireland,' iii. plate facing p. 140, 1906) has published a series of figures of antler-growth in the Fallow Deer (*Dama*) illustrating precisely the same phenomenon.

† Die Säug. p. 667, 1904.

‡ P. Z. S. 1910, p. 840.

absence of interdigital glands on the feet and the smoothness of the integument between the hoofs in *Elaphurus* corroborated Sir Victor Brooke's views as to the relationship between this animal and such Old World deer as *Rusa*, *Rucervus*, and *Cervus*, and weakened to a corresponding degree the claim for affinity between it and the

Text-fig. 110.

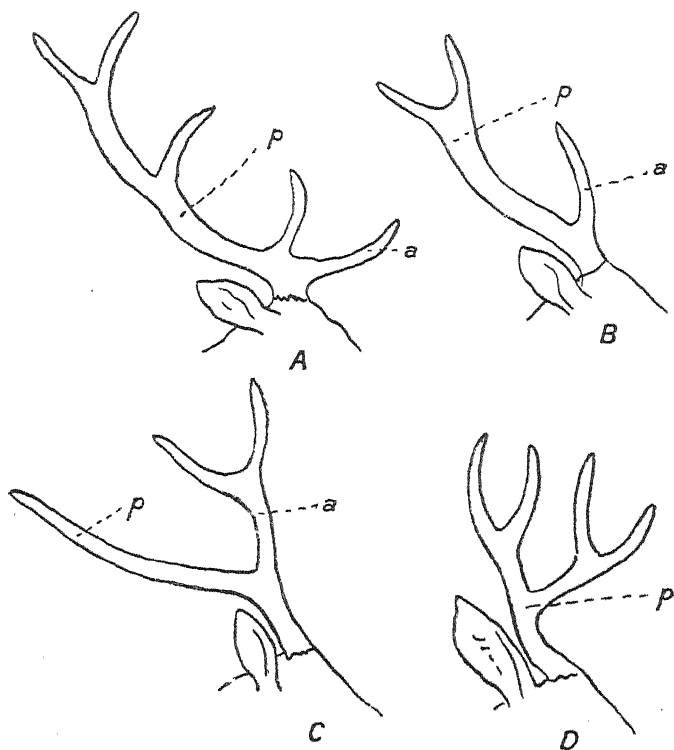


Diagram of the Antlers of four genera of Cervidae, to illustrate the homologies established in this paper.

A. *Cervus*. B. *Rusa*. C. *Elaphurus*. D. *Odocoileus*.

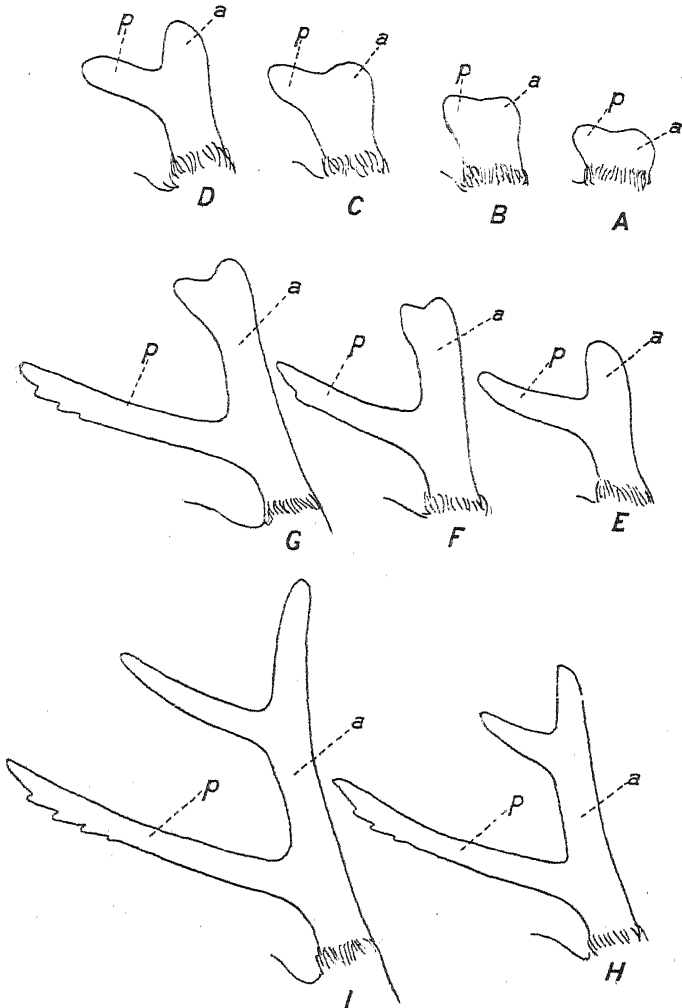
*a*, anterior and *p*, posterior branch. In *A* and *B* the anterior branch is called the "brow-tine" and the posterior branch the "beem." *B* is somewhat intermediate between *A* and *C*. They differ collectively from *D* in having the anterior branch well developed. In *D* it is small and concealed behind the highly developed posterior branch.

Telemetacarpal species, in all the members of which examined by me, belonging to the genera *Mazama*, *Odocoileus* (*Dorcilaphus*), *Capreolus*, *Rangifer*, and *Alces*, the skin between the hoofs is



thickly hairy and, in all but *Alce*, a large pouch-like interdigital gland is present at least in the hind foot.

Text-fig. 111.



Nine stages (*A* to *I*) in the growth of an Antler of *Elaphurus davidianus*, showing that the branches marked *a* and *p* correspond precisely in origin with the brow-tine and the beam of other genera of Old World Deer. Compare *D* and *E* with fig. 108, *D*.

(From sketches made at Woburn and kindly supplied by Lord Tavistock.)

Thinking, for these reasons, that there must be some flaw in the claim that the antlers of *Elaphurus* differ fundamentally from those of, say, *Rusa*, I suggested the following homologies:— In *Rusa* the antlers have a short base, a short undivided anterior branch or brow-tine, and a large divided posterior branch or beam; in *Elaphurus* they have a longer base, a very large divided and more erect anterior branch or brow-tine, and a correspondingly reduced, comparatively slender, divided or undivided posterior branch or beam.

This, however, was a mere guess, which I was unable to substantiate by any evidence of much value. Believing, however, that the growth of the antlers in *Elaphurus* would finally settle the question one way or the other, I asked Lord Tavistock if he would kindly observe the process for me on one of the stags at Woburn. This he was good enough to do, and sent me in addition the series of sketches reproduced in text-figure 111.

These sketches show, in my opinion, that my guess was, as I expected, correct. In the first three stages the antler is little more than an excrescence dividing into an anterior and a posterior bud. In the fourth stage the base is beginning to lengthen, the anterior bud to grow upwards, and the posterior bud nearly straight backwards. This process continues during the succeeding stages, the anterior branch gradually taking the lead in size and importance, and becoming divided distally into two tines. I can see no escape from the conclusion that the anterior and posterior buds of the very young antler in this stag are the homologues of the corresponding buds in the young antler of the Barasingha (*Rucervus duvaucelli*) shown in text-fig. 109. That being so, it is clear that the anterior branch of the antler of *Elaphurus* is homologous with the "brow-tine" and the posterior branch with the "beam" of the antler in the Red Deer, Sambar, Barasingha, and other deer characteristic of the Old World. The differences between them are mainly a matter of size and direction of growth; that is to say, they are differences of degree and not of kind\*.

#### *Antler-Growth in a Species of Odocoileus.*

Writing of the antlers of the typical American Deer, Mr. Lydekker said †:—"A large amount of misconception has arisen with regard to the structure of the antlers of this group. In 1872 the late Dr. Gray rightly termed the single upright prong arising from the inner side of the lower part of the beam of the antlers of the Virginian Deer the 'subbasal snag'; but this snag

\* The subdivision of the anterior branch of the antler in *Elaphurus* is, of course, no argument against it being the homologue of the "brow-tine," for the latter not infrequently, though abnormally, produces an additional snag in Elaphine and allied groups of deer. In some species indeed, as in the Irish Elk and *Cervus eldi*, it is commonly and normally provided with supplementary processes.

† 'Deer of All Lands,' p. 246.

Sir Victor Brooke incorrectly identified with the brow-tine of the typical Old World deer. This error has been pointed out by Mr. A. Gordon Cameron, [who stated that] these characteristic tines have nothing in common with the true brows of Old World types, and rise vertically from the inner side of the beam between the coronet and the main furcation, usually converging at the apex. They are subject, in common with the antlers that produce them, to all kinds of eccentricities; are frequently forked or sub-palmate."

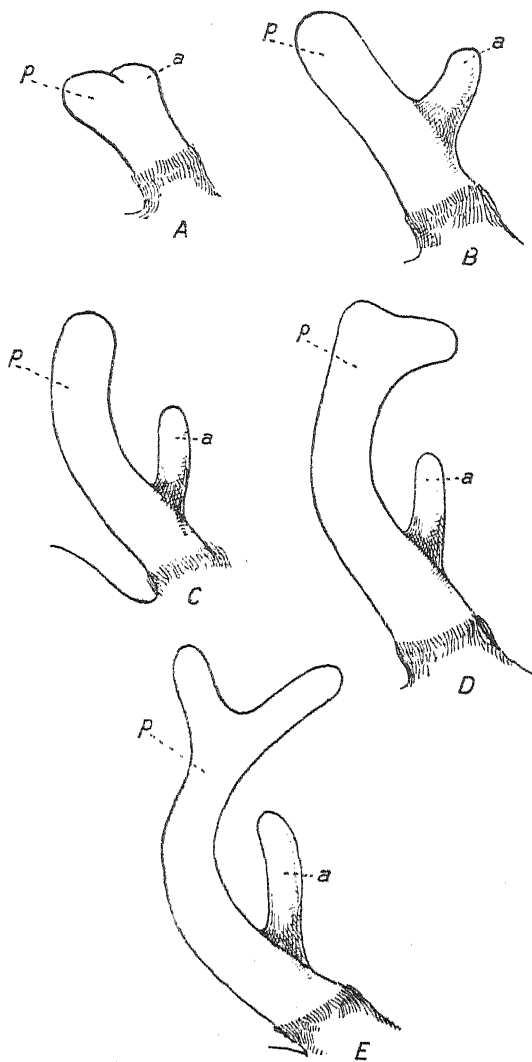
Mr. Lydekker writes as if Mr. Cameron's *dictum* settled the question at issue; but it does not appear to me that much weight can be attached to the reasons adduced by the latter for his dogmatic denial of the truth of Sir Victor Brooke's interpretation of what Gray called the "subbasal snag" in the Virginian deer. Except that the tine in question is situated on the inner side of the antler, there is no great difference between it and the brow-tine of the Old World stags, which is highly variable in direction, as a comparison between the antlers of, e. g., *Cervus affinis* and *Rusa aristotelis* will show. Not less does it vary in size and structure even in nearly allied forms, as is testified by *Dama dama*, where it is large, by *Dama mesopotamica*, where it is sometimes almost suppressed, and by the Irish Elk, believed to be a Damine stag, where it may be palmated and branched.

The question to be settled, then, is this:—Does the position of this tine on the inner side of the antler in the Virginian deer preclude its being the homologue of the brow-tine situated on the front of the antler in the Old World deer? Study of the growth of the antler justifies, in my opinion, a negative answer to this question and shows that Sir Victor Brooke's opinion was correct.

Early last year the Society received from the northern part of South America a male specimen of *Odocoileus*, which I cannot determine accurately. It is smaller and browner than a Venezuela specimen identified as *O. savannarum*, but is otherwise very like it. Its antlers are short, with the beam curved forwards in the upper portion and ending in two tines, an anterior and a posterior; while on the inner side, near the base, arises the so-called "subbasal snag."

The growth of these antlers was very instructive. They started as a simple excrescence, which soon began to divide into an anterior and a posterior bud, the only difference between the antlers at this stage and those of a typical Old World deer being that the anterior bud was slightly internal and projected a little inwards as well as forwards. Nevertheless the two buds were perfectly visible in profile view. The appearance of the antler at this stage is shown in text-fig. 112, *A*, taken on May 12th. Four more stages of the growth are represented in the following figures, *B-E*, taken respectively on May 22nd, May 30th, June 6th, and June 17th, which show very markedly the gradual assumption of an apparently more internal position by the anterior branch, its

Text-fig. 112.



Five stages (*A* to *E*) in the growth of an Antler of an American Deer (*Odocoileus* sp. incert.), showing that the "subbasal snag" (*a*) and the "forked beam" (*p*) were respectively the homologues of the "brow-tine" and the "beam" of the typical Old World Deer. Compare *B* with fig. 108, *D*.

point of attachment to the posterior branch being completely concealed from the external aspect in the last three stages\*.

In view of these facts, I do not think it can be doubted that the anterior bud which develops into the "subbasal snag" in *Odocoileus* is the homologue of the anterior bud which forms the brow-tine in *Cervus*. In that case the "subbasal snag" and the "brow-tine" are homologous structures passing under different names, and to state that *Odocoileus* has no brow-tine is merely playing with terminology.

If this interpretation of the structure of the antlers in *Elaphurus* and in the species of *Odocoileus* above referred to be, as I believe, correct, it shows that these two genera are widely divergent in the very point upon which relationship between them has been claimed to exist, and that the likeness, such as it is, between the antlers of *Elaphurus* and of the Mule Deer (*O. hemionus*), for instance, which has the so-called forked antlers without a brow-tine or with the merest vestige of it, is purely a question of parallelism in development; that is to say, it has been brought about by growth and modification of fundamentally different parts of the antler. In the Mule Deer the anterior branch or brow-tine is to all intents and purposes suppressed, practically the whole antler being composed of the posterior branch or "beam," which is highly developed and heavily tined. In *Elaphurus*, on the contrary, the principal part of the antler is composed of the anterior branch or "brow-tine," which attains a large size and is divided into two prongs, while the posterior branch or beam remains comparatively small and slender and projects straight backwards as a long often undivided prong.

\* In connection with the date of antler-change in this Stag, attention may be directed to its approximate coincidence with that of the typical elaphine deer of the Old World; that is to say, the antlers were in the velvet during the summer months and functional during the autumn and winter. They were shed in the early spring and at the time of writing (July 3) the new antlers are nearly full-sized though still in the velvet, exactly as in our Wapiti, Red Deer, Japanese Deer, and other Old World species. The same is true of a specimen of *Odocoileus americanus*. On the other hand an example of *Mazama tricenii* which shed in April 1908, and again in April 1909, did not repeat the process till May 1911. He then carried a pair of antlers for 25 months; and those that started to grow in May 1911 are still on his head. Thus Dr. Scharff ('Distribution and Origin of Life in America,' p. 111) is mistaken in saying that the antler-change in American deer takes place at a quite different time of year from that of Old World deer. It is well known too that the time of antler-change at all events in some tropical Old World deer is highly variable within specific limits. For instance, one example of *C. duvaucelli* in the Gardens regularly carries his antlers till about the end of May, while another of the same species has antlers at least half their full size at that time.

47. Polychæta from the Pacific Coast of North America.—  
Part I. SERPULIDÆ, with a Revised Table of Classification of the Genus *Spirorbis*. By HELEN L. M. PIRELL, B.Sc., F.Z.S., Demonstrator of Zoology and Reid Fellow, Bedford College, University of London.

[Received May 6, 1912: Read June 4, 1912.]

(Plates LXXXVII.—LXXXIX. <sup>\*</sup>)

Systematic:	INDEX.	Page
<i>Apomatus timsii</i> , sp. n. ....		787
<i>Protula pacifica</i> , sp. n. ....		788
Classification of <i>Spirorbis</i> .....		792
<i>Protolæospira</i> , subgen. n. ....		798
<i>Spirorbis ambilateralis</i> , sp. n. ....		798
<i>S. racemosus</i> , sp. n. ....		799
<i>S. medius</i> , sp. n. ....		800

*General Characteristics of the Family Serpulidæ.*

1. Tube calcareous, nearly always attached to rocks or other substratum for some part of its length.
2. Generally one or more branchiæ on dorsal side terminated by an operculum.
3. Thorax, generally provided with a thoracic membrane, representing the fused cirri and having 3-9 (usually 7) segments.
4. Gland shields in thorax only.

Genus SERPULA Linné (12) 1767, Philippi (21) 1844.

Generic characteristics † :—

1. Collar setæ of bayonet-shape, with spines at base of blade.
2. Operculum funnel-shaped, with numerous radii ending in serrations on margin.
3. Uncini with only a few large teeth.

1. SERPULA COLUMBIANA Johnson (9), 1901. (Pl. LXXXVII. fig. 1.)

*Serpula splendens* Bush (3), 1905.

*Serpula columbiana* Moore (19), 1909.

Specific characteristics :—

1. Anterior abdominal setæ with flaring fringed ends, short and deeply embedded, posteriorly replaced by small fascicles of very long stiff spines.

\* For explanation of the Plates see p. 805.

† An attempt is here made to summarise briefly the generic and specific characteristics in every case. Such a procedure has not previously been adopted, so far as I know, and it will, no doubt, in some cases be necessary at some future time to modify such characteristics, but in the present confused state of our systematic knowledge of the Serpulids, this seems to be a course likely to eliminate some of the difficulties.

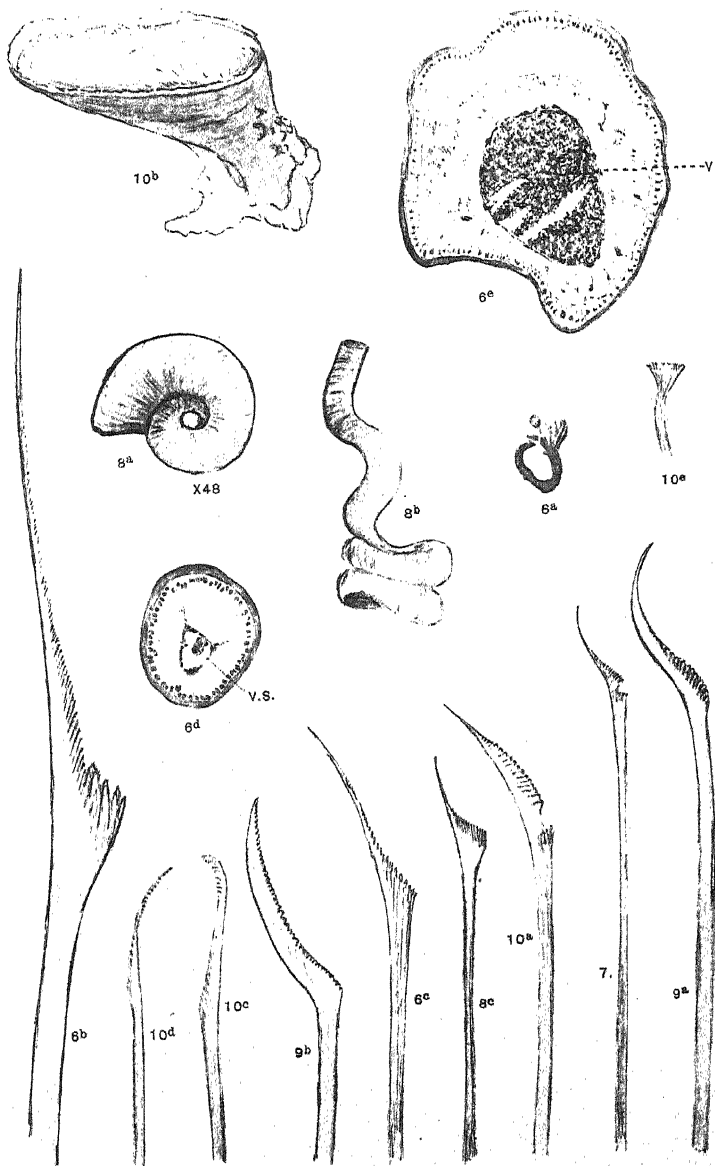


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NORTH AMERICAN SERPULIDÆ.

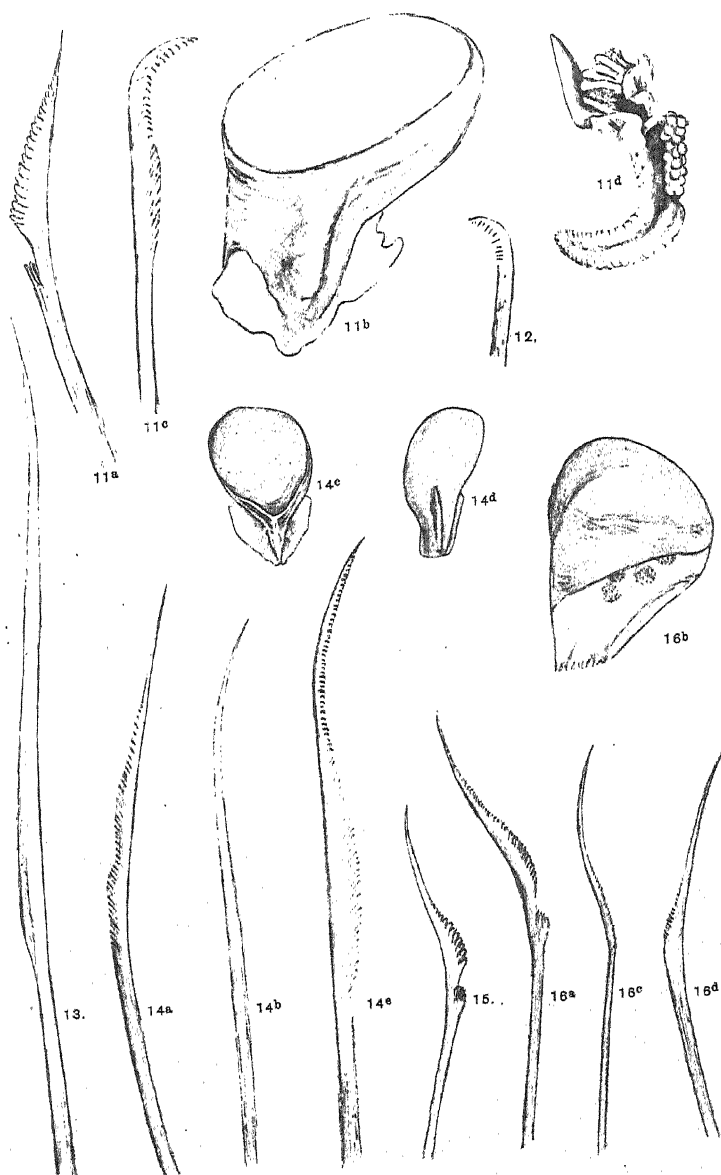






London Stereoscopic Co. imp.





London Stereoscopic Co. Imp.

NORTH AMERICAN SERPULIDÆ.



2. Uncini generally 6 or 7 teeth, the anterior one being the largest (figs. 202 & 203 Johnson, 9).
3. Very large size (fig. 1) with numerous abdominal segments, 30 to 54 branchiæ and from 80 to 160 serrations on edge of operculum.

Numerous specimens from Departure Bay, Dodds' Narrows, and two from Puget Sound (Prof. Kincaid's collection).

Isolated tubes are to be found attached to the undersides of stones on rocky shores near extreme low-water mark, and small colonies may be found above this level in rock-pools.

In other places attached to rocks near low-water level the masses of large white calcareous tubes are very striking—they are thick and often finely ridged, the lower parts being much intertwined, the free distal ends often overgrown with Polyzoa, *Spirorbis*, etc.

The brilliant red colour on the branchial crown may involve the whole of the gills and operculum, or these may be colourless except for the tips, or they may be barred and mottled in a large variety of ways. The remainder of the body is generally yellowish.

As regards collar, thoracic membrane, and operculum with its tubercles, this species agrees very closely with *S. vermicularis*, so fully described by St.-Joseph (24. pp. 328-335). Johnson (9) presumably has made it into a new species on account of its very much greater size with corresponding greater number of abdominal segments, branchiæ and serrations on operculum, together with small differences in the setæ and uncini. He cannot, I think, have examined many specimens, for he states that the functional operculum is on the right side (9. p. 432). The position of this in the genus *Serpula* may be right or left as shown by Zeleny (27. p. 34), but out of 50 specimens that I have examined 28 had it on the left, 21 on the right, and the remaining specimen had one on each side. Consequently, when he says that there are *about* 100 serrations on the edge of the operculum, I cannot think that Bush (3) is justified in recording this as a distinction between this species and *S. splendens* with 127 to 150 serrations.

Moore (19) gives 140 for the one specimen of *S. columbiana* in which he counted the serrations. In my specimens they vary from about 80 to 160—the number apparently increasing with age.

Another distinction given by Bush is that there are in *S. columbiana* "but 250 abdominal segments in a length of 55 mm.," whereas Johnson says "250 or more" (9. p. 432), and she gives 313 as the number in a specimen of her so-called *S. splendens*, of which she does not state the size, and 190 in a specimen 35 mm. long. These figures speak for themselves I think as creating nothing but confusion. In 15 of my specimens the average number of abdominal segments was 236, including 79 in a specimen 10 mm. long, 142 in a specimen 41 mm. long, and 310 in one 81 mm. long.

The third point of difference given by Bush is that *S. columbiana* has more numerous branchiae—54 in each lobe as given by Johnson—than her *S. splendens*, for which she records 45 to 50 pairs.

In the specimen of the former species counted by Moore (19) there were only 38. One small specimen of mine had only 18, but the general number was from 30 to 50 on each side, one or two large specimens having as many as 54—the number given by Johnson. These facts show clearly I think that *S. splendens* is a quite unnecessary species and can be included in *S. columbiana*, which in turn, as pointed out by Johnson (9, p. 433), may be identical with *S. jukesii* Baird, for which however no satisfactory description was given.

Numerous large free Selenidia in the trophozoite stage were found in the alimentary canal of nearly every specimen of *S. columbiana* examined.

#### Genus CRUCIGERA Benedict (1), 1886.

Generic characteristics :—

1. Collar setae and uncini similar to those of *Serpula*.
2. Operculum with comparatively few radii forming a scalloped margin to the funnel and with conspicuous basal processes.

#### 2. CRUCIGERA ZYGOPHORA Johnson. (Pl. LXXXVII. fig. 2.)

*Serpula zygophora* Johnson (9), 1901.

*Crucigera zygophora* Bush (3), 1905.

Specific characteristics :—

1. Branchiae about 30 pairs with long filamentous ends to rachises.
2. Operculum thick, shallow, with about 30 radii and 3 rounded processes at its base; attached by a long pedicle.

One specimen from Puget Sound was 45 mm. long. A smaller incomplete specimen came from Victoria (fig. 2). Another specimen was only 7 mm. long and had a much thinner operculum, but seemed otherwise similar.

#### 3. CRUCIGERA IRREGULARIS Bush (3), 1905. (Pl. LXXXVII. fig. 3.)

Specific characteristics :—

1. Branchiae much coiled and with comparatively short filamentous ends to rachises.
2. Operculum irregular, apex of funnel displaced ventrally and the posterior and lateral walls deeper and rolled over to some extent. Not more than two basal processes which may, however, be bi-lobed and attached by long stout pedicle (fig. 3).

About 12 specimens from the Channel outside Departure Bay

and one from Dodds Narrows. Depth 15 to 25 fathoms. Tubes generally solitary, attached to stones, shells, old wood, etc. Only one specimen is recorded by Bush from Juneau. Tubes much coiled, with flaring ends and one or two other conspicuous ridges at intervals indicating the flaring end of a younger tube. Young tubes seem to develop with a centimetre or so attached more or less straight along the substratum, then to coil indifferently to right or left, and only at a much later stage, if at all, to ascend and form the flaring end.

General colour pale orange, the branchiæ and operculum variously mottled and barred with red. Pinnæ sometimes golden; ova greenish. Length varies from about 14 mm. to 50 mm. (fig. 3).

Largest diameter of operculum 1.3 to 4.5 mm.; the latter had 32 radii forming a thick scalloped edge. The pedicle was bifid and contracted at the top just before joining the basal processes of the operculum (fig. 3). Setæ as figured by Bush (3); in the posterior region of the abdomen the ordinary setæ are replaced by small fascicles of long slender spines.

#### Genus *APOMATUS* Philippi (21), 1844.

Generic characteristics:—

1. Operculum globular, terminating a gill retaining its pinnæ.
2. Some thoracic setæ bladed sickles (setæ of *Apomatus*) (fig. 4 c).
3. Terminal dorsal gland present.

#### 4. *APOMATUS TIMSII*, sp. n. (Pl. LXXXVII. figs. 4 a-4 f.)

Specific characteristics:—

1. Collar setæ simple tapered blades (fig. 4 b).
2. Branchiæ about 40 pairs with pinnæ nearly to the ends of rachises.
3. Uncinigerous tori begin on third setigerous segment.
4. Uncini with numerous small teeth, the posterior one larger with terminal enlargement (fig. 4 f).
5. Abdominal setæ more or less sickle-shaped with some long filiform ones in the last segments.

Eleven specimens from the Channel outside Departure Bay in about 20 fathoms. This is the first time apparently that the genus has been recorded from the Pacific Coast of America.

The tubes are solitary, adherent, and sinuous—one was attached along its whole length to a portion of the Hexactinellid sponge *Aphrocallistes whiteavesianus*.

When full-grown about 80 mm. with 150 abdominal segments (fig. 4 a).

The branchial rachises are much coiled and almost colourless, with pairs of red spots up their outer surfaces and only short filiform extremities—the pinnæ appear green due to the contained blood. The thorax is more or less orange or red, the thickened

ridges bearing the tori being especially deep in colour. Abdomen pinkish; there is a short anterior asetigerous region, and posteriorly nearly covering the last centimetre or so of dorsal surface is a chalky white strap-shaped raised glandular area. This is the terminal dorsal gland mentioned by St.-Joseph (24) as possibly serving in the construction of the tube. It tapers anteriorly and ends abruptly posteriorly just above the vertical slit-like anus.\* Along nearly the whole of this glandular region the ordinary abdominal setæ are replaced by fascicles of about five slender capillary setæ without blades and nearly equal in length to the width of the abdomen at this place. The collar is entire ventrally and has a deep incision on each side—the lateral lobes being continuous with the wide thoracic membrane.

The functional operculum is large and transparent and carried by the second branchia from the dorsal side. The pedicle is generally coiled twice like the other gills; except in very young specimens there is a small club-shaped one terminating the branchia on the opposite side.

All the collar setæ and most of the other thoracic setæ have simple narrow blades; amongst them in the posterior thoracic fascicles are to be found a few of the typical bladed sickles (fig. 4 *c*). The abdominal setæ are more or less sickle-shaped, though they easily become folded (figs. 4 *d*, *e*) or straightened out.

Several of the specimens examined were much smaller and obviously young forms, with 70, 83, 101, 114 abdominal segments and fewer branchiæ than in adult specimens.

#### Genus *PROTULA* Risso (23), 1826.

Generic characteristics :—

1. No operculum.
2. Collar setæ simple tapered blades (fig. 5 *b*).
3. Terminal dorsal gland present.

#### 5. *PROTULA PACIFICA*, sp. n. (Pl. LXXXVII. figs. 5 *a* 5 *f*.)

Specific characteristics :—

1. Ventral lobe of collar notched.
2. Abdominal setæ somewhat sickle-shaped in the anterior region, narrow terminal bladed ones posteriorly.
3. Uncinigerous tori extend from segment 3 to the end of the abdomen.
4. Uncini with numerous small teeth, the posterior one long with a bulbous extremity (fig. 5 *f*).
5. Thoracic setæ simple blades with sometimes a few setæ of *Apomatus* posteriorly.

\* In section the gland is seen to consist of epithelial cells crowded with spherical granules which stain easily with iron hæmatoxylin but not with Delafield's. The gland is apparently unchanged by the presence of acid in the preservatives and therefore does not appear to be calcareous.



Three specimens from Fairway Channel outside Departure Bay in about 30 fathoms; one from Puget Sound (Prof. Kincaid's collection). No tube.

The specimens were colourless except for the branchiæ, which appear greenish due to the contained blood. Down the outer side of each branchial rachis was a line of opaque white spots.

The branchial crown (10–15 mm. high) easily falls off, leaving a scar; the remainder of the body is 38 to 60 mm. long, rather more than one-third of which is thorax. This is broad and flattened with nearly parallel sides (fig. 5*a*) and the usual 7 setigerous segments. The thoracic membrane is very wide, with an entire margin which can extend beyond the setæ but is generally considerably crumpled. The collar is notched in the median ventral line and has a deep fissure on each side. The inward coil of the stout base of the branchial crown is seen on the right side of the specimen in fig. 5*a*. It takes  $1\frac{1}{2}$  to 2 turns inwards and upwards, the short inner gills reaching about the same height as the outer long ones. An interbranchial membrane connects the lower third of the gills, of which there are about 60 pairs having small closely placed pinnæ almost to their extremities. At the junction of the branchiæ with the stout basal membrane which carries them there is a slight ridge visible externally, and at this place on the inner side arises the oral membrane, which is continuous across the median line and up each of the spirals. On the dorsal side of the mouth is another shorter membranous lip.

Uncini begin on the third setigerous segment. They have the characteristic shape (fig. 5*f*). The first two millimetres or so of the abdomen is achæitous, nearly round, and of smaller diameter than the wide dorso-ventrally depressed part which follows. The ventral surface has deep segmental grooves showing 83–110 segments, and a wide faecal groove which turns to the right on reaching the thorax. Laterally the short tori are raised on distinct parapodial processes which extend to the posterior end of the body. The last 30 or so segments on the dorsal surface are covered with the calcareous-looking gland which anteriorly tapers off to two points, suggesting a paired origin.

In section the gland is seen to occupy nearly the whole thickness of the dorsal body-wall, the longitudinal muscles being pushed towards the sides. Nearly all the cells are crowded with the spherical granules or globules which stain easily with iron hæmatoxylin, and are apparently similar to those in the glandular cells so frequently found in the epidermis.

This hind region of the abdomen has very long setæ which extend 2 mm. or more on each side but are easily broken. At first sight they appear to be simple spines very slightly bent at the extremities, but, with high magnification, a narrow striated wing may be made out (fig. 5*e*), shorter setæ found with these are more distinctly winged (fig. 5*d*). The other abdominal segments have ventral fascicles containing about 13 short, stout,

somewhat sickle-shaped setæ (fig. 5c). These setæ were, unfortunately, not examined before being preserved, and as St.-Joseph (24. p. 338) points out, a lengthened immersion in alcohol tends to reduce the curve of the sickle.

In general structure this species resembles *P. capensis* McIntosh (13) fairly closely, but differs in the shape of the setæ and uncini: in the latter respect and in some other points it differs, too, from *P. diomedea* Benedict (1). There are many characteristics distinguishing it from *P. superba* Moore (19) and other Pacific species that have been described. *P. atypica* Bush (3) might possibly be a young specimen of this same species.

#### Genus CHITINOPOMA Levinsen (10), 1883.

Generic characteristics:—

1. No thoracic membrane.
2. Collar setæ with fin-like expansion at base of blade.
3. Some of the other thoracic setæ are sickle-shaped.
4. Abdominal setæ geniculate.
5. Uncini with 9 or 10 fine teeth, the anterior one being larger and blunter than the others.
6. Operculum with horny plate.

#### 6. CHITINOPOMA GREENLANDICA. (Pl. LXXXVIII. figs. 6 a-6 e.)

*Serpula triqueter* Fabricius (7), 1780.

*Hydroides norvegica* var. *grönlandica* Mörch (20), 1863.

*Hydroides* (?) *grönlandica* Malmgren (14), 1867.

*Chitinopoma fabricii* Levinsen (10), 1883.

Specific characteristics:—

1. Bodies elongated, somewhat cylindrical.
2. About 6 pairs of branchiæ with ends free from pinnæ.
3. Operculum enclosing central stalked vesicle.

Numerous specimens from Departure Bay and neighbourhood, one incomplete one from Victoria. In thick sinuous tubes adherent to shells, stones, etc., and having a very conspicuous dorsal keel generally ending in a spine overhanging the aperture. One tube was U-shaped with the two ends close together. The largest specimen was about 12 mm. long (fig. 6a). The whole animal was practically colourless, the pedicle of the operculum and the branchiæ sometimes having faint transverse bands, and the contents of the alimentary canal were in some specimens dark red.

The branchiæ varied very much in number (from 6 to 8 in each lobe) and some were frequently found in a rudimentary state: one specimen had 7 in the right, and only 3 fully-developed functional ones in the left. The operculum was in every case on the left dorsal side, and I have found no trace of a secondary one on the other side.

The full-grown branchiæ had about 17 pairs of ciliated pinnae, which stopped short some distance from the top of the rachis leaving a fairly long filamentary end. In sections the rachises are seen to be strengthened externally by a thick layer of chitin, which also forms a protecting layer round the pedicle (fig. 6 *d*), and is continuous over the operculum with the thick horny plate on its top. This plate was often covered with sand, and many specimens had infusorians, etc. attached to it. The central coelomic space in the pedicle is lined with peritoneum provided with very large conspicuous nuclei. There is a small vessel running along its whole length and enlarging in the opercular cup into a spherical vesicle (fig. 6 *e*). This is filled with a finely granular precipitate, and from its wall and general appearance seems to correspond with the branchial blood-vessels of the ordinary gill rachises, though I do not see that it can have any respiratory function. It is apparently suspended in a fine reticulate connective-tissue which easily shrinks away from the epithelial cells; Leviusen, in his original description (10. p. 203), suggested that it might be a new operculum forming in the old one.

The collar is very wide—the entire ventral lobe being generally reflexed—the latero-dorsal lobes are continued down the dorsal side to between the second and third thoracic setæ, where they end abruptly, giving the appearance of a short thoracic membrane. This was a constant characteristic in both small and large specimens. I have not seen it referred to before, but do not think it necessary on that account to separate this as another species.

With the large collar setæ (fig. 6 *b*) are a few shorter curved forms with very narrow blades.

The abdominal setæ agree with those described by St.-Joseph (24) for the genus (fig. 6 *c*).

The abdomen is long and slightly dorso-ventrally flattened, with 25–40 segments. The tori contain about 17 uncini, but there are only a few setæ to each segment. The dorsal longitudinal muscles are greatly developed—there is a small fascicle of ventral ones on each side of the wide faecal groove. The large ventral nerve-cords are separated from one another. The epithelium consists of low columnar cells with numerous gland-cells containing the usual spherical masses which stain easily with iron hæmatoxylin.

This species seems to agree very closely with that described by Bush (3) as *Hyalopomatopsis occidentalis*. I cannot understand why this form with *no* thoracic membrane and “trumpet-shaped” abdominal setæ is put in a genus, of which St.-Joseph writes (24. p. 264): “Il m’a fallu créer un genre nouveau *Hyalopomatopsis* pour le *Hyalopomatus langerhansi* Ehl. et le *H. marenzelleri* Lang., qui par la présence d’une membrane thoracique . . . ne pouvaient rentrer, comme l’avait dû rester prévu Langerhans, dans le genre *Hyalopomatus* tel que l’avait

défini von Marenzeller." St.-Joseph also gives as another characteristic of his genus *Hyalopomatopsis*, the presence of capillary setæ in all the abdominal segments.

Genus SPIRORBIS Daudin (6), 1800.

(Pls. LXXXVIII., LXXXIX. figs. 7-16.)

Generic characteristics and Schemes of classification :—

1. Calcareous tubes coiled in a dextral or sinistral spiral. The method of coiling and the markings on the tube have been used by Bush (3) in drawing up Table I., but the coiling of the tubes is variable (*cf.* figs. 8 *a* and *b*), being determined to a great extent by the nature of the substratum, and as Caullery & Mesnil (5) have already pointed out there is no constancy in either coiling or markings.
2. Branchiæ are constant in different species, the operculum with terminal calcareous plate, always occurring as the second on the concave side (*i. e.* the right in dextral forms and left in sinistral; since the animal lies with its back towards the substratum).
3. Thoracic segments generally 3—the first having only dorsal setæ—the two following have on each side an uncinigerous torus as well. In the subgenera given the prefix *Para-* by Caullery & Mesnil an extra torus (and in *Sp. cancellatus* a fascicle of dorsal setæ also) is developed on the concave side of the animal; this condition has been described in the following Table of Classification (p. 794) as  $3\frac{1}{2}$  setigerous segments.

In *Sp. ambilateralis*, sp. n., there are four complete setigerous segments, although the fourth on the convex side is very reduced. This specimen therefore approaches the hypothetical *Prospirorbis*, described by Caullery & Mesnil (5. p. 233), who point out that the genus *Spirorbis* has been evolved from other Serpulidæ, which have the characteristic greater number of thoracic segments, by a gradual reduction. I have therefore placed this species in a new sub-genus *Protolaospira*.

4. Abdominal segments 8-40.

Between the thorax and the abdomen is a more or less long asetigerous region—often crowded with ova. The spermatozoa develop in the posterior setigerous segments.

5. The thoracic setæ are distinctive and the differences are of use as specific characteristics. Table II. given by Bush (3. p. 261) is drawn up with regard to these and the direction of the coiling alone.

As a rule, the first thoracic segment has some slender capillary setæ forming the inferior part of the fascicle (fig. 14 *b*)—the

superior ones, referred to as *collar setæ*, are distinctive, they may have simple blades (fig. 13) or there may be a distinct fin-like expansion at the base of the blade (figs. 7, 10 a, 11 a). In the case of sinistral forms Caullery & Mesnil referred the former to their sub-genus *Romanchella*, putting only those with a distinct fin in the sub-genus *Leospira*. In the species *S. verruca* and *S. evolutus* Bush and *S. medius*, sp. n., however, the setæ are intermediate between these two types, having blades which are faintly notched (fig. 14 a), showing an indication of a superior blade and inferior fin. Consequently I propose to do away with Caullery & Mesnil's sub-genus *Romanchella* altogether—taking *Leospira* to include all sinistral forms with three setigerous segments: it thus comes into line with the other three sub-genera proposed by Caullery & Mesnil (*cf.* Table of Classification).

The second thoracic segment has only ordinary bladed setæ, differing very little from one species to another.

The third thoracic segment has some ordinary bladed setæ, but generally also some bladed sickles as found so generally in the genus *Apomatus* (fig. 14 e).

In many Pacific species there are present instead of the ordinary bladed sickles a peculiar shorter form which appears almost fringed at the extremity (fig. 10 c).

6. Abdominal ventral setæ generally geniculate.

7. *Uncini* similar in thorax and abdomen—plates with the free edge provided with fairly numerous fine teeth, the anterior one being larger than the others.

The following Table of Classification has been adapted from that given by Caullery & Mesnil in their excellent paper on *Spirorbis* (5) to include such of the Pacific forms as have so far been studied. These authors pointed out that such a modification would possibly be necessary.

Unfortunately the majority of the new species described by Bush (2, 3, 4) from California, Alaska, and Japan cannot be included owing to absence of information as to the number of thoracic segments. Two or three of the species are established on details as to the tubes alone.

Sub-genus PARADEXIOSPIRA Caullery & Mesnil (5), 1897  
(modified).

Characteristics:—

1. Tube dextral.

2. Thorax with  $3\frac{1}{2}$  setigerous segments.

7. SPIRORBIS VITREUS Fabr., 1780. (Pl. LXXXVIII. fig. 7.)

*Serpula vitrea* Fabricius (7), 1780.

*Spirorbis vitreus* Mörch (20), 1863; Malmgren (14), 1867;

Levinsen (10), 1883; Caullery & Mesnil (5) 1897;

Moore (17), 1902; Bush (3), 1905.

TABLE OF CLASSIFICATION OF THE GENUS *SPIROBIS*.

SUB-GENERA.			
Paradexiospira. 3½ thoracic segments.	{	Last thoracic segment with dorsal setae. Collar setae with fins .....	<i>S. canaliculatus</i> Fabr.
		Last thoracic segment without dorsal setae .....	{ Collar setae with fins ... <i>S. vitreus</i> Fabr. Collar setae without fins, <i>S. violaceus</i> Lev.
Dexiospira. 3 thoracic segments.	{	Incubation in Tube.	{ Collar setae without fins. Abdomen 10-20 setigerous segments..... <i>S. spirillum</i> L. (var. <i>S. americanus</i> St.-J.) Collar setae with fins ..... { <i>S. marioni</i> C. & M. <i>S. semidentatus</i> Bush.
		Incubation in Operculum.	{ <i>S. pseudocorrugatus</i> Bush. ( <i>corrugatus</i> C. & M.) <i>S. rugatus</i> Bush. <i>S. compactus</i> Bush. <i>S. foraminosus</i> Bush. <i>S. bellatus</i> Bush. <i>S. formosus</i> Bush.
		Bladed sickles in 3rd setigerous segment.....	{ Hepatic pigment violet.. <i>S. pagenstecheri</i> Qfg. Hepatic pigment red ... <i>S. pusilloides</i> Bush. ( <i>pusilla</i> St.-J.)



Specific characteristics :—

1. Last thoracic segment on the right has no dorsal setæ.
2. Collar setæ with fin-like expansions at base of deeply serrated blades.
3. Some setæ of third segment bladed sickles.
4. Embryos incubated in the tube.

This species was quite common on stones and rocks from the Departure Bay region and from Victoria.

The tubes vary a good deal but are always translucent, with the whorls piled on one another. The whole tube measures about 2.5 mm. in diameter and the aperture about 1 mm. across. There are various markings on the exterior. Sometimes a ridge along the median line ends in a sharp projection above the aperture—in the grooves on either side of this there may or may not be scalariform markings. Young specimens have shells as figured for this species by Levinsen (10, fig. 11), older ones were ridged more like *Sp. cancellatus* (10, fig. 18). The living animals were bright pink in colour. Gills 7, each with six pairs of long opposite pinnæ, opercular plate a shallow funnel. About 20 abdominal segments.

Sub-genus DEXIOSPIRA (Caullery & Mesnil, 1897).

Characteristics :—

1. Tubes dextral.
2. Thorax with 3 setigerous segments.

8. SPIRORBIS SPIRILLUM Linné, 1767. (Pl. LXXXVIII. figs. 8a-8c.)

*Serpula spirillum* Linné (12), 1767; Fabricius (7), 1780.

*Spirorbis spirillum* Malmgren (14), 1867; Levinsen (10), 1883; Caullery & Mesnil (5), 1897; Moore (17), 1902; Bush (3), 1905.

*Spirorbis lucidus* Montagu (16), 1803; Mörch (20), 1863; Malmgren (14), 1867.

*Circeis armoricana* Saint-Joseph (24), 1894.

*Spirorbis borealis* Fewkes (8), 1885.

Specific characteristics :—

1. Collar setæ geniculate (fig. 8c).
2. Operculum without brood-pouch.
3. Concave plate of operculum has a slight projection (talon) on under side.

Two varieties of this species were fairly common in the Departure Bay region and at Victoria, growing on calcareous polyzoa, seaweeds, etc. The discoid form grows only on smooth surfaces, Laminarian thalli being often extensively covered with specimens. These were very flat, regularly coiled tubes—the spiral with  $1\frac{1}{2}$  to 3 coils measuring .5 to 2 mm. in diameter (fig. 8a). The



ascending variety in some localities is much more common than the discoid one, and it grows to a much larger size (fig. 8 *b*), often attaining a height of 5 mm. It was generally found with its lower coils overgrown with an orange Bryozoan growing on *Chaetopterus* tubes.

The living animal had a reddish colour, with a colourless transparent operculum. A string of pink ova extended along the tube beyond the posterior end of the body in some specimens. There were 3 thoracic and from 12 to 20 abdominal segments.

The collar setæ attain a length of .27 mm., much larger than those figured by Caullery & Mesnil (5. fig. 4 *b*), they resemble more closely in shape those given for *S. armoricanus* (5. fig. 5 *b*).

The differences between these two species were pointed out by Caullery & Mesnil (5. p. 199) to be quite unimportant. All that they could summarise were that *Sp. armoricanus* (*Circeis armoricanus* St.-Joseph (24. p. 350)) was slightly larger, had more abdominal segments (16-20) and a reduced talon to the operculum. They record having seen intermediate forms themselves, and the above observations as to variation in size, the number of abdominal segments, and the collar setæ consequently confirm their opinion that *Sp. armoricanus* should be considered as a variety only of *Sp. spirillum*.

9. SPIRORBIS PUSILLOIDES Bush (3). (Pl. LXXXVIII. figs. 9 *a*,  
9 *b*.)  
*S. pusillus* Caullery & Mesnil (5), 1897.  
*Mera pusilla* St.-Joseph (24), 1894.  
Non *S. pusillus* Rathke (22 *a*), 1836.

Specific characteristics:—

1. Collar setæ of a more or less geniculate form (fig. 9 *a*).
2. Embryos incubated in operculum.
3. Setæ of 3rd thoracic segment sickle-shaped.
4. Hepatic pigment reddish brown.

On stones from Taylor's Bay, Gabriole Island. This animal agrees in all important points with the full description by St.-Joseph (24. p. 351) for *Mera pusilla*. The collar setæ are a little more distinctly angulated at the base of the blade (fig. 9 *a*), but they have not the typical geniculate form described by Caullery & Mesnil (5. p. 202). They are much shorter than the setæ of the second segment and are decidedly hooked. The extent to which the setæ are hooked has been pointed out by St.-Joseph to be reduced by preservation (24. p. 338), so that this does not seem to be a very important point.

The opercular brood-pouch is somewhat cylindrical and bounded proximally and distally by calcareous plates, the talon is reduced to a small quadrangular projection.

The abdomen has eight segments, with large, more or less sickle-shaped setæ (fig. 9 *b*) and an asetigerous anal segment.

Sub-genus *PROTOLÆOSPIRA*, nov.

1. Tube sinistral.
2. Four complete setigerous segments to thorax.

10. *SPIRORBIS AMBILATERALIS*, sp. n. (Pl. LXXXVIII. figs. 10 *a*–10 *e*.)

Specific characteristics :—

1. Collar setæ very large, conspicuously serrated blades with fin-like expansion at base (fig. 10 *a*).
2. Operculum without brood-pouch.
3. Talon of operculum with large hook-like process (fig. 10 *b*).
4. Some setæ of 3rd segment have fringed ends (fig. 10 *c*).
5. Some setæ of 4th segment ordinary bladed sickles.
6. Abdominal setæ brush-like (fig. 10 *e*).
7. Dorso-lateral brood-pouch.

Several specimens on the inner sides of shells of *Balanus nubilus* from Dodds Narrows, 15–25 fathoms. Tubes forming translucent sinistral spirals measuring 3 to 4 mm. across. The surface is distinctly corrugated outside, highly polished inside; the aperture measures 1 mm. in diameter.

Branchiæ 12—6 on the right, and the operculum with 5 others on the left. The pinnæ extend upwards and reach the same height as the rachises. The opercular plate (fig. 10 *b*) is very like that of *S. cornu-arietis* Marion & Bobretzky (15). From close to the point of origin of the pedicle arises a wide tube which passes across the dorsal surface beneath the left lateral lobe of the collar, and enlarges into the thin-walled brood-sac which lies along the dorso-lateral surface on the right side. This structure has never, so far as I am aware, been described before: it is figured and more fully described for *S. racemosus*, in which species it was first seen.

Collar wide and entire; the collar setæ rather more than 1 mm. in length (fig. 10 *a*). Setæ of 2nd segment very numerous, all with simple blades; these appear again in the 3rd fascicle, and with them some shorter bladed setæ with their extremities more or less curved and fringed (fig. 10 *c*). The setæ of the 4th thoracic segment are few in number; on the convex side of one specimen there were three bladed sickles (fig. 10 *d*) and three with plain blades. The uncigerous tori on the 4th segment are also smaller than on the two preceding, especially on the right (convex) side. The thoracic uncini are about 90  $\mu$  long and have 20–25 teeth. Those on the abdomen are only 25  $\mu$  in length. About 50 of the latter make up each of the tori which are very distinct on the 18–20 abdominal segments: they begin quite close to the posterior end of the thorax—the anterior asetigerous region of the abdomen being very short.

The collar setæ in this form seem to have been specially

developed, for according to Caullery & Mesnil (5) the possession of blade and fin is not a primitive characteristic, and they are also very large; possibly they are specially developed in correlation with its habitat in rapids where the tide runs from 7-9 knots an hour. The presence of the specially developed brood-pouch might perhaps receive a similar explanation.

#### Sub-genus PARALÆOSPIRA.

1. Tubes sinistral.
2. Thorax with  $3\frac{1}{2}$  setigerous segments.

#### 11. SPIRORBIS RACEMOSUS, sp. n. (Pl. LXXXIX. fig. 11.)

Specific characteristics:—

1. Collar setæ with fin-like expansion at base of very coarsely serrated blade (fig. 11 *a*).
2. Operculum with massive talon having lateral wings and a hook on ventral surface (fig. 11 *b*).
3. Thin-walled dorsal or lateral brood-pouch attached to the thorax at the base of the operculum (fig. 11 *d*).
4. Some setæ of 3rd fascicle bladed sickles (fig. 11 *c*).

A few large specimens from San Juan Island on barnacle-shells overgrown with calcareous sponge; smaller ones from Channel outside Departure Bay. Depth in both places 15 to 25 fathoms.

The largest specimen measures 5 mm. across the spiral; the tube is corrugated and generally rather loosely coiled, leaving a central hole.

Branchiæ 13—6 functional ones on each side; rachises have short tapered extremities without pinnæ; operculum not unlike that of *S. ambilateralis*, but the talon rather more massive and its outer concavity almost hemispherical and filled with debris.

The collar setæ are very large (fig. 11 *a*); the 2nd fascicle consists of plain-bladed setæ, and the 3rd contain some fringed sickles as well. There is a distinct third uncinigerous torus on the left side (fig. 11 *d*); the uncini have the usual shape.

There are 21 well-marked abdominal segments, each with three or four brush-like setæ and a long asetigerous anal segment. The brood-pouch with its distinct wide stalk seems to be peculiar to this and the last described species of *Spirorbis*: it does not apparently replace a gill, for the calcareous operculum is developed as usual on the 2nd to the left. The sac has a very thin wall, the large ova causing marked protuberances on its surface, the whole somewhat resembling a bunch of grapes (fig. 11 *d*).

#### Sub-genus LÆOSPIRA.

1. Tube sinistral.
2. Thorax with 3 setigerous segments.

12. *SPIRORBIS ASPERATUS* Bush (3), 1905; Sitka. (Pl. LXXXIX. fig. 12.)

Specific characteristics:—

1. Collar setæ with simple blades.
2. Operculum without brood-pouch.
3. Calcareous plate of operculum thin, with large lateral wings on its talon.
4. Some setæ of 3rd fascicle short fringed sickles (fig. 12), others with long narrow blades.

On an old Serpulid tube inhabited by a hermit crab. One specimen only. The opaque sinistral tube shows conspicuous growth-lines, and the whorls are somewhat piled on one another.

There are 12 or 13 reddish gills nearly hidden by the high collar, above which the operculum projects for some distance. The alimentary canal was greenish and the ova along the dorsal surface salmon-pink. The abdomen consisted of about 20 segments.

13. *SPIRORBIS VALIDUS* Verrill (26), 1874. (Pl. LXXXIX. fig. 13.)

*S. verruca* Levinsen (10), 1883, figs. + Caullery & Mesnil (5), 1897; Moore (17), 1902.

*S. validus* Bush (3), 1905.

Specific characteristics:—

1. All thoracic setæ with long, finely serrated, narrow blades (fig. 13).
2. Operculum with brood-pouch.
3. Opercular plate (Bush (3), pl. xliv. figs. 11-14).
4. Branchiæ 13.

On old shells of *Balanus nubilus* from Dodds Narrows, 15 to 28 fathoms.

The tubes were smooth, sinistral, and opaque, measuring 3 mm. in diameter. The operculum was colourless and transparent, with a large sac-like brood-pouch which was, however, empty in specimens collected on September 1st. The gills and thorax were of a bright orange-red colour, the rachises being thick with a double row of small pinnae extending inwards at right angles. Abdomen with 25 segments having a few setæ, some being somewhat geniculate, others small hooks (Bush, pl. xxxvii. figs. 5 & 6).

14. *SPIRORBIS MEDIUS*, sp. n. (Pl. LXXXIX. figs. 14 a-14 e.)

Specific characteristics:—

1. Some collar setæ with shallow posterior notch (fig. 14 a).
2. Operculum without brood-pouch.
3. Calcareous plate of operculum very large and of characteristic shape (figs. 14 c & d).
4. Some setæ of 3rd segment serrated bladed sickles (fig. 14 e).

From Channel just outside Departure Bay. Large flat tubes

thick and opaque, slightly roughened, but without definite growth-lines. A slight median ridge and sometimes one on either side; the aperture has, however, an entire margin and measures 2 mm. across.

The animal is of a uniform brick-red colour, and its total length is 4.5 mm; there are 14 branchiæ—7 being joined at their bases and situated on the right side; the other 6 functional ones are joined with the operculum on the left. Each rachis has a thin membranous projecting flap which wraps round the outside of the next, and thus gives rise to a series of imbricating semilunar membranes just inside the base of the collar. The total height of the gills is 1 mm. There is a very wide thoracic membrane on the right side which almost envelops the whole animal. The calcareous plate of the operculum is 1.5 mm. along its long axis; the outer side is concave and generally covered with sand; the talon projects obliquely inwards and has large wing-like expansions at the sides (figs. 14 *c* & *d*). The collar setæ (fig. 14 *a*) appear to be in an intermediate stage between plain bladed form and that with a distinct fin-like expansion at the base of the blade—in one specimen I could find none of these, only forms with the ordinary blades. In the 2nd segment there were numerous setæ of the normal kind, and the 3rd fascicle was made up of bladed sickles (fig. 14 *e*) and ordinary bladed setæ. The two tori in the thorax consisted of uncini of the ordinary shape with about 20 teeth. In the abdomen were counted 20 to 25 segments, and the setæ were of the ordinary geniculate type.

15. *SPIRORBIS LANGERHANSI* Caullery & Mesnil (5), 1897, and Bush (3), 1905, from Panama. (Pl. LXXXIX. fig. 15.)

Specific characteristics:—

1. Collar setæ with fin-like expansion at base of coarsely serrated blade (fig. 15).
2. Embryos incubated in operculum.
3. Operculum of characteristic shape (5. fig. 22).

On tubes of *Serpula columbiana* from Departure Bay. Tubes small, marked with lines and ridges.

The structure of the animals agrees with the description given by Caullery & Mesnil (5. p. 217). They are 1–2 mm. long, the abdomen being broad, with a long asetigerous region followed by 9 short setigerous segments.

16. *SPIRORBIS MÖRCHI* Levinsen (10), 1883 (Greenland); Caullery & Mesnil (5), 1897; Bush (3), 1905. (Pl. LXXXIX. figs. 16 *a*–16 *d*.)

Specific characteristics:—

1. Collar setæ about 12, with fin-like expansion at base of coarsely serrated blade (fig. 16 *a*).
2. Embryos incubated in operculum (fig. 16 *b*).
3. Branchiæ 8.

Numerous specimens on tubes of *Serpula columbiana* from Departure Bay. The opaque tubes are pressed together with their ends standing erect, their bases being overgrown with an encrusting sponge; the surfaces are free from regular markings, the apertures being circular and measuring about 1 mm. in diameter.

The animals vary in colour, some being almost colourless, but were generally some shade of red or brown.

The setæ of the 2nd and 3rd thoracic segments have long, very narrow, delicately serrated blades (fig. 16c). A few of the 3rd are shorter, with small posterior blades; these probably represent straightened sickles (fig. 16d).

There is a deep collar and a wide thoracic membrane on the right side only—this traverses the ventral surface obliquely towards the end of the thorax and covers over several segments of the abdomen. The gill rachises are thick and have long pinnæ, the seven normal respiratory ones are rather taller than the one bearing the operculum. The latter is protected at its extremity by a convex calcareous cap which extends nearly to the base of the brood-pouch on the ventral side. The top is quite opaque and slightly bilobed. Fifteen or more large reddish ova were contained. Abdominal segments 20–29 with normal geniculate setæ.

#### 17. *SPIRORBIS VARIABILIS* Bush (3), 1905; Sitka.

Specific characteristics:—

1. Collar setæ coarsely serrated blades with posterior fins.
2. Operculum without brood-pouch.
3. Talon of operculum without projections.

On stones and tubes of *Serpula columbiana* from Departure Bay and neighbourhood. Thick tubes about 1 mm. across with the outer whorl spreading over the others to some extent; surface markings were not very distinct.

General colour brick-red, with cerise ova along the dorsal surface.

Branchiæ 8 (including operculum), are nearly hidden by the high collar. The thoracic membrane on the right side is very much developed. The opercular plate had a marked concavity on its outer side, and a small almost central talon projecting inwards. The setæ agree with those described by Bush (3). The abdominal segments varied a great deal in number, from 15 to 28.

#### 18. *SPIRORBIS QUADRANGULARIS* Stimpson (25), 1853.

*Spirorbis quadrangularis* Mörch (20), 1863, and Bush (3), 1905.

*Spirorbis fabricii* Malmgren (14), 1867.

*Spirorbis carinatus* Levinsen (10), 1883 + (11), 1886 + Montagu (16), 1803.

*Spirorbis affinis* Levinsen (10), 1883.

*Spirorbis granulatus* Moore (17), 1902 + (?) Caullery & Mesnil (5), 1897.

Specific characteristics :—

1. Collar setæ finely striated blades with basal fin.
2. Operculum with large brood-pouch.
3. Convex calcareous cap with long cylindrical projection (figs. 14, 15, pl. xliii., Bush (3) 1905).

Victoria ; two specimens only obtained.

Tubes measure 2 and 3 mm. across respectively ; each has a very conspicuous median ridge and two lateral ones, the outer one being at the top of the perpendicular outer wall. The striations on the blades of the collar setæ could hardly be distinguished at all. Some setæ in the third fascicle were serrated, bladed sickles. The collar and thoracic membrane were well developed on the right side, and there was a long asetigerous region following the thorax. There were 12 abdominal segments with geniculate setæ.

Most of the specimens described in this paper were obtained during a stay at the Marine Biological Station, Departure Bay, Vancouver Island, in the summer of 1911. Mr. F. A. Potts kindly collected those from Puget Sound and some others: I should like to take this opportunity of thanking him, also the Rev. G. W. Taylor, F.R.S.C., Curator of the Marine Laboratory, Departure Bay, for his kindness and help with regard to dredging arrangements, and Dr. Marett Tims for his advice and assistance throughout.

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## EXPLANATION OF THE PLATES.

## PLATE LXXXVII.

- Fig. 1. *Serpula columbiana* from left side,  $\times 2$ .  
 Fig. 2. *Crucigera zygophora*, anterior end from right side,  $\times 2$ .  
 Fig. 3. *Crucigera irregularis*, whole animal from right side,  $\times 2$ .  
 Fig. 4. *Apomatus tinsii*. 4*a*, whole animal from the right side,  $\times 3$ , *d.g.*, dorsal terminal gland; 4*b*, collar seta,  $\times 300$ ; 4*c*, bladed sickle-shaped seta from thorax,  $\times 300$ ; 4*d*, crumpled anterior abdominal seta,  $\times 300$ ; 4*e*, short posterior abdominal seta  $\times 300$ ; 4*f*, thoracic uncinus,  $\times 300$ .  
 Fig. 5. *Protula pacifica*. 5*a*, ventral view,  $\times \frac{3}{2}$ ; 5*b*, thoracic seta,  $\times 300$ ; 5*c*, anterior abdominal seta, embedded up to the dotted line,  $\times 200$ ; 5*d*, short posterior abdominal seta,  $\times 300$ ; 5*e*, tip of long posterior abdominal seta,  $\times 300$ ; 5*f*, abdominal uncinus,  $\times 300$ .

## PLATE LXXXVIII.

- Fig. 6. *Chitinopoma greenlandica*. 6*a*, dorso-lateral view,  $\times 2$ ; 6*b*, collar seta,  $\times 460$ ; 6*c*, abdominal seta,  $\times 460$ ; 6*d*, transverse section through pedicle of operculum, *v.s.* stem of vesicle,  $\times 55$ ; 6*e*, transverse section through operculum showing vesicle (*v*) suspended in a loose connective tissue,  $\times 48$ .  
 Fig. 7. *Spirorbis vitreus*, collar seta,  $\times 220$ .  
 Fig. 8. *Spirorbis spirillum*. 8*a*, tube of discoid variety,  $\times 48$ ; 8*b*, tube of ascending variety,  $\times 10$ ; 8*c*, collar seta,  $\times 200$ .  
 Fig. 9. *Spirorbis pusilloides*. 9*a*, collar seta,  $\times 460$ ; 9*b*, large abdominal seta,  $\times 460$ .  
 Fig. 10. *Spirorbis ambilateralis*. 10*a*, collar seta,  $\times 220$ ; 10*b*, calcareous plate of operculum, lateral view,  $\times 48$ ; 10*c*, seta from 3rd thoracic segment, showing fringed sickle-shaped extremity; 10*d*, ordinary bladed sickle, from 4th segment (twisted end); 10*e*, brush-like abdominal seta. *c-e*,  $\times 220$ .

## PLATE LXXXIX.

- Fig. 11. *Spirorbis racemosus*, sp. n. 11*a*, collar seta,  $\times 220$ ; 11*b*, calcareous plate of operculum,  $\times 48$ ; 11*c*, seta from 3rd thoracic segment,  $\times 460$ ; 11*d*, dorsal view of whole animal showing stalked brood-pouch,  $\times 12$ .  
 Fig. 12. *Spirorbis asperatus*, seta from 3rd thoracic fascicle,  $\times 460$ .  
 Fig. 13. *Spirorbis validus*, collar seta,  $\times 460$ .  
 Fig. 14. *Spirorbis medius*, sp. n. 14*a*, collar seta showing shallow posterior notch,  $\times 460$ . 14*b*, ordinary capillary seta from 1st fascicle,  $\times 460$ . 14*c*, calcareous plate of operculum, dorsal view, showing talon and lateral wings,  $\times 16$ . 14*d*, latero-ventral view of opercular plate, showing flat talon with lateral wing-like projections,  $\times 16$ . 14*e*, serrated bladed sickle,  $\times 460$ .  
 Fig. 15. *Spirorbis langerhansi*, collar seta,  $\times 460$ .  
 Fig. 16. *Spirorbis mörchi*. 16*a*, collar seta,  $\times 220$ . 16*b*, operculum containing ova, lateral view,  $\times 48$ . 16*c*, narrow seta of 2nd and 3rd fascicles,  $\times 220$ . 16*d*, seta from 3rd fascicle,  $\times 220$ .

## EXHIBITIONS AND NOTICES.

May 21, 1912.

Sir EDMUND G. LODER, Bt., Vice-President,  
in the Chair.

The SECRETARY read the following report on the additions made to the Society's Menagerie during the month of April 1912:—

The number of registered additions to the Society's Menagerie during the month of April last was 291. Of these 165 were acquired by presentation, 61 by purchase, 17 were received on deposit, 8 in exchange, and 40 were born in the Gardens.

The number of departures during the same period, by deaths and removals, was 189.

Amongst the additions special attention may be directed to:—

1 Rüppell's Guereza (*Colobus abyssinicus occidentalis*) ♂, from the Southern Cameroons, deposited on April 29th.

1 Black Jaguar (*Felis onca*) ♀, from Para, purchased on April 12th.

1 Capped Langur (*Semnopithecus pileatus*), 2 Elands (*Taurotragus oryx*), 1 Common Camel (*Camelus dromedarius*), and 1 Ursine Tree-Kangaroo (*Dendrolagus ursinus*), born in the Menagerie.

A collection of birds from Columbia, presented by W. K. Pomeroy, Esq., F.Z.S., on April 6th, containing amongst others, 2 Purple Jays (*Cyanocorax affinis*), new to the Collection; 1 Harpy Eagle (*Thrasaetus harpyia*); 2 Severe Macaws (*Ara severa*); and 2 Golden Hangnests (*Icterus xanthornus*).

2 Lämmergeiers (*Gypaëtus barbatus*), from Russian Turkestan, purchased on April 19th.

1 large Reticulated Python (*Python reticulatus*), from the East Indies, presented by Rowland Ward, Esq., F.Z.S., on April 19th.

Mr. A. BLAYNEY PERCIVAL, F.Z.S., exhibited a number of photographs and lantern-slides of Game Animals from British East Africa, including a fine series of the Reticulated Giraffe.

Mr. D. SETH-SMITH, F.Z.S., Curator of Birds, exhibited two living specimens of a rare Lory, *Calliptilus solitarius*, from Fiji, and remarked that Dr. Philip H. Bahr had recently brought home two specimens which had died. The specimens exhibited were from a collection of eight brought home alive by Mr. Rood Tarte, of Taviuni Island, one of the Fijian group, where this very beautiful species was still abundant, its numbers having been very considerably reduced in the other islands by the introduced

mongoose. The exhibitor referred to a recent note on the species by Dr. Bahr in 'The Ibis' for April 1912, p. 293.

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Mr. G. A. BOULENGER, F.R.S., F.Z.S., read a paper entitled "Second Contribution to our Knowledge of the Varieties of the Wall-Lizard." This paper was a continuation of one published in the Society's 'Transactions' in 1905, and dealt chiefly with the variations of *Lacerta muralis* in South-Eastern Europe and South-Western Asia. It also contained a supplement to the first part, thus completing an account of the varieties, of which about thirty were regarded as more or less definable, the author endeavouring to show the inconstancy of the characters adduced by some herpetologists in assigning specific rank to a number of these forms, connected by many gradations. Mr. Boulenger hoped to support his statements by a number of photographic figures of specimens selected out of the enormous material which had passed through his hands in the course of his study of this polymorphic and widely distributed lizard.

This paper will be published in the 'Transactions' in due course.

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June 4, 1912.

E. G. B. MEADE-WALDO, Esq., Vice-President,  
in the Chair.

Mr. E. G. BOULENGER, Curator of Reptiles, exhibited a clay-ball containing a cocoon of the African Lung-fish (*Protopterus annectens*) presented to the Society by Capt. J. A. M. Vipan, F.Z.S. He briefly alluded to the habits of the fish and the formation of the cocoon, and gave an account of the method to be employed in order to release the fish.

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*The Preservation of the Native Fauna of Great Britain.*

Mr. E. G. B. MEADE-WALDO, Vice-President of the Society, introduced a discussion on the Preservation of our Native Fauna, in which Mr. A. Heneage Cocks, Dr. F. G. Dawtrey Drewitt, and Mr. Stewart Blakeney (who sent a written contribution) joined. The necessity of creating public opinion on the matter was urged. It was agreed that the laws with regard to birds were sufficient, if administered strictly. With regard to mammals, it was the opinion of those present that the use of steel traps, instead of snares, for catching rabbits was chiefly responsible for the extermination of wild cats, martens, and polecats in many parts of the country, and ought to be suppressed.

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## PAPERS.

48. The One-sided Reduction of the Ovaries and Oviducts in the Amniota, with Remarks on Mammalian Evolution.  
By HANS GADOW, M.A., Ph.D., F.R.S., F.Z.S.

[Received May 31, 1912: Read June 4, 1912.]

## INDEX.

	Page
Anatomical Structure and Development.....	803

Sanguine morphologists reckon that it takes about ten years for their discoveries to find their way into a text-book. It takes a generation to eradicate erroneous statements, especially generalisations, out of such books, since most of them are repeated from others without consultation of the immense host of original papers. And it is apparently hopeless to expect the enthusiast or amateur to appreciate the difference between a generalising text-book of comparative anatomy and a zootomical account. It means progress for a branch of science if we can inscribe upon its statute-book a few lines of true generalisation, which, if there be no hedging, require no longer any concrete examples to be mentioned. If only partial generalisations are possible, of course the exceptions are to be recorded and every new case is welcome, until their accumulation in turn permits of being summarised. Then let there be drawn a line, and let the discoverer of further cases keep his peace unless he has something new to say.

The condition of the bird's ovaries and oviducts is a case in point. The main facts have by now become ancient history and general knowledge to the zoologist, so ancient that the original workers have been forgotten, as much as the name of the originator of the term morphology.

That the ovaries and ducts of birds are one-sided was probably known since time immemorial. Perrault\* described and figured them in the Ostrich without further comment. In the year 1810 Wolf mentioned that he had usually found two ovaries in the Sparrow-hawk, a fact duly incorporated by Tiedemann† in his excellent work, which reveals him as a zoologist far ahead of his time. Next, Spangenberg‡ figured the right ovary in a Duck. Barkow§ described the occurrence of right-sided rudiments of the female generative apparatus in various other birds. Emmert|| observed equally large right and left ovaries in the Sparrow-

\* PERRAULT: *Mémoires pour servir à l'histoire naturelle*. Amsterdam, 1736.

† TIEDEMANN: *Anatomie und Naturgeschichte der Vögel*. 1810.

‡ SPANGENBERG: *Disquisitiones circa partes genitales femineas Avium*. Gottingæ, 1813, 4to.

§ BARKOW: *Von der Kloake verschiedener Vögel*. Meckel's Archiv f. Anat. u. Phys., 1829.

|| EMMERT: *Reil-u. Authenriet's Archiv*.

hawk and some other Accipitres. When Nitzsch made his anatomical contributions to Naumann's 'Naturgeschichte' he knew already of quite a number of cases of double ovaries. R. Wagner\* added to them in his *Lehrbuch*, and still more in his *Beiträge*. He described the cases of double ovaries accompanied by double ducts; he knew that vestigial ducts are much rarer than ovaries, and was well aware of the fact that even in Accipitres with double ovaries there may be no traces of a second duct, etc. Stannius† added further cases in his *Lehrbuch*. It was, however, mainly owing to Wagner's lists that Duméril could give a general summary in Cuvier's posthumous edition of his 'Anatomie comparée,' published in 1836. Owen‡ also felt justified in summarising without referring any more to special cases. On p. 247 of his work he says:—"The symmetry [of the ovaria] is soon disturbed by concentration of development in the left ovarium, the right one remaining stationary, and ultimately, in most birds, disappearing." On p. 249: "Subsequently the left oviduct alone proceeds to grow; the right is stationary, or shrivels; occasionally it may be discovered as a rudiment in the mature bird, but usually all trace of it has disappeared."

Still further instances of abnormalities have been described and even figured without adding to or upsetting the generalisations quoted above. In most of the general text-books and others, which have occasion to mention these organs, the quotation of certain birds has become a regular stock in trade, always the same, copied from one author by the next, who in turn is quoted as the original authority by the more popular writer.

So far as I know, I was the first to give a possible explanation of the one-sided reduction, and I translate here what I wrote in Bronn's 'Thierreich,' p. 842, published in 1890. "In all birds only the left ovary is completely formed and functional; the right is present in most cases, and may even produce unripe eggs, but these degenerate later and seem never to become free. In correlation herewith the right oviduct undergoes early reduction; at most it persists towards the cloaca as a ligamentous strand, may be even as a tube which opens into the cloaca. This one-sided development of ovary and oviduct may be referable to saving of space. Two completely developed, hard-shelled eggs would scarcely have room in the belly, and we may add that even in the left oviduct two complete eggs seem to be very exceptional, if such ever occur. In Reptiles, however, both ovaries and ducts are equally developed."

This idea could not have been expressed more guardedly than by the following sentence in the 'Dictionary of Birds,' p. 783: "This one-sided suppression of the organs may possibly be

\* WAGNER: (1) *Lehrbuch der vergleichenden Anatomie*, 1834.

(2) *Beiträge zur Anatomie der Vögel*. Abhandl. Münch. Akad. Wiss. ii. 1837, pp. 271-283.

† STANNIUS'S *Lehrbuch der vergleichenden Anatomie*. 1846.

‡ OWEN: *Anatomy of Vertebrates*, vol. ii. 1866.

referable to the inconvenience that might be caused were each oviduct to contain an egg ready to be deposited." Mr. Gunn\* takes a reporter's liberty by substituting for "inconvenience" various gruesome calamities, as fracture of the egg-shell, rupture of the oviduct, and even peritonitis! After thus having tried to throw ridicule upon my generally accepted notion, he assures us that such evil sequences need not be assumed at all because of "the frequency with which Falconidæ are found with paired ovaries, which are obviously functional." Then he proceeds to distinguish between several theoretical possibilities besides the only actual condition, namely, that in which the functional organs are those of the left side.

Not a single case is known of a completely developed right duct, whilst the left is vestigial. Further, I withdraw the statement made in the 'Dictionary of Birds,' that "but with rare exceptions only that [ovary] on the left side becomes functional." "Functional," I regret to say, was there used in a loose way, since the right ovary not unfrequently forms rather large eggs. But strictly it should be called functional only if any of those eggs ever became ripe, *i. e.* burst from the ovary. We know that even relatively large ovarian eggs, even those of the left side, can undergo complete reduction†.

Mr. Gunn, however, taking for granted that growing eggs in both ovaries mean that both are functional, and that, although two ovaries may not be a necessity, they must be better than one (a principle which has produced the double-barrelled gun), has to face the question whether one oviduct can serve two ovaries. We are told that "there is not much evidence for or against this supposition," and that "there seems no physical objection to the open end of the tube swinging across the mid-line of the spine, and grasping the right ovum of the opposite ovary with nearly the same facility as the ovum of its own side." One physical objection to this amazing trick-performance may be the gut with its loops and mesenteries, and it is at least doubtful whether the agile tube (the infundibulum of which is most carefully anchored opposite its own ovary) can overcome these obstacles, in spite of the best-intentioned regulating nerve-stimulus.

Let us enquire further into the meaning of the one-sided reduction of the female bird's reproductive organs.

Gegenbaur‡ favours the size of the egg, the complete egg with albumen and shell, as the primary cause:—"Bei den Vögeln gelangt nur das linke Ovar zu seiner völligen Ausbildung dh. nur

\* T. E. GUNN.—"On the Ovaries in certain British Birds," P. Z. S. 1912, p. 63. Mr. Gunn and the Rev. F. C. R. Jourdain credit the late Prof. Newton with the authorship of the article "Reproductive Organs" in the 'Dictionary of Birds,' and they suggest as his "German source" of original information Taschenberg's Introduction to Naumann's 'Naturgeschichte,' re-edited in 1905, eleven years *after* the 'Dictionary of Birds.'

† Cf. A. von Brunn: "Die Rückbildung nicht ausgestossener Eierstockseier bei Vögeln." Beiträge zur Anatomie und Embryologie, als Festgabe für Jakob Henle. Bonn, 1882.

‡ Vergleichende Anatomie der Wirbelthiere, ii. 1901, p. 503.

in ihm kommen Eier zur Reife, und das rechte erhält sich nur bei einzelnen (manchen Accipitres, Schwimmvögeln und einzelnen Gattungen verschiedener Abtheilungen) fort, indess es bei den übrigen verkümmert. Dies steht in Zusammenhang mit der Ausbildung nur eines (des linken) Oviductes und mit dem bedeutenderen Volum der Eier, wodurch jeweils nur einem einzigen ein längerer Aufenthalt in der engen Beckenhöhle gestattet ist. *Es ist also hier die Rückbildung einer Hälfte des gesamten weiblichen Geschlechtsapparates von der Ausbildung des Eivolums abhängig*, und dadurch an einen höheren Zustand geknüpft, dass das mit reichlichem Eiweiss und Dotter ausgestatte Ei das sich in ihm entwickelnde Junge zu einer bedeutenderen Ausbildung gelangen lässt." The correlations mentioned in these cumbrously involved sentences are valid enough, but they do not carry the question any further than where I had left it.

Since the ovary is the prime organ and the duct merely auxiliary, it might be assumed *a priori* that the primary cause of the reduction was the cessation of the production of ripe eggs on one side, whereupon degeneration of the corresponding duct would follow, as there would be no longer any work for it. Illicit, undesirable traffic is stopped best by cutting off the supply, in the present case by the stoppage of ripening eggs at the source. But, as we have seen, this does not agree with the facts, considering the frequent activity of right ovaries, whilst right ducts are much rarer. Further, we know that even comparatively far advanced ovarian eggs can be resorbed. Lastly, we should have every right to expect birds with right, and others with left functional organs. It cannot well be assumed that the one-sided reduction is an inheritance from reptilian ancestors, of which unfortunately we know nothing. Of recent reptiles only Crocodiles and Tortoises can be studied for the sake of analogy. These produce for one clutch a considerable number of hard-shelled eggs which pass through both ducts. The eggs are well protected, and there is ample room for them in the broad body of Chelonians, and there is likewise space and safety in the long belly of a Crocodile.

Presumably therefore the cause of the asymmetry should lie in the typical organisation of the bird. In proportion to its body the eggs are enormous, especially in some of the nidifugous groups which represent the lower conditions. They could not well produce the whole clutch at once; and they incubate their eggs, not merely because they require several days, even weeks, to produce the full number, but because as warm-blooded creatures they have reached a higher state of reproductive organisation. There is no room within the pelvis for more than one complete hard-shelled egg, leaving aside the inconvenience of a right and a left egg which, for argument's sake, might be overcome, as is actually the case with reptiles. The available space in the bird's belly is limited; the longitudinal distance is relatively much shorter than in the majority of reptiles which are devoid of a sacrum, and the peculiar pelvis of birds is as

broad as is compatible with the upright walking and with the flying organisation. Most likely the broadness and the absence of symphyses have been produced in adaptation to the eggs, but even the distention of the belly downwards must be limited in the bird, which is essentially and primarily a flying creature.

Well, then, let us take it that it is advantageous that one of the ducts and the activity of the corresponding ovary should be suppressed. Instances of asymmetry, brought about by suppression of one of originally paired organs, are common enough in the Vertebrata, and they can in most cases be fairly explained by mechanical factors. To refer them to mere accident, to a toss up, which then becomes established, is too shallow a mode, although not unprecedented in morphology. The tadpoles of some *Anura* have paired "spiracles," others a median, the majority a left hole. The reduction of one of the lungs of Snakes and snake-shaped Lizards is of course directly correlated with the shape of the body, and it appears almost optional whether the right or the left lung should be affected, since both cases have become established in the various groups.

If we apply the principle of elimination of all those unfortunate hen-birds which happened to produce eggs in either side, whilst only those birds propagate the race which happen to have only one side in working order, this would not explain the universal right-sided suppression, which according to Gegenbaur is a weighty argument for the monophyletic origin of the class\*. If we assumed this as a proof of their monophylism, we should logically arrive not only at the imaginary pair of "Urvögel" but also at the Eve of hens, which in her case would relegate the establishment of the asymmetry to a toss up. During the presumably long period of dawning bird-life such a one-sided incipient suppression must have taken place over and over again before it was firmly established. Inheritance, if not swamped by panmixis, might have established asymmetry, but once more we are groping in the dark for a cause which favours the left side. It must be a factor which is very ancient and yet does not interfere with the symmetry of the male organs, neither the testes nor the vasa deferentia. Since the ovaries are strictly homologous, or rather homogeneous, with the testes, this may be taken as another hint that the ovaries are not the parts primarily affected. But the male ducts are not the same as the female ducts, therefore the latter are indicated. No factor causing the asymmetry can be derived from the vascular system, nor even from the vestiges of the renal portal system, by the suppression of which birds and mammals differ from their common ancestors, the reptiles. To refer the enlarged left ovary and duct to the

\* The suppression of one lung in Snakes, etc. stands on a different footing. It may be due to an accident or sport, as much as right- and left-clawed crabs, or right- and left-twisted shells. The remaining lung enlarges and shifts its position so as to occupy most of the space originally intended for both.—H. G.



stronger arterial supply would of course mean mistaking effect for cause\*.

A sufficient cause, however, may be the fact that a full oviduct is less liable to disturb the other intestines in the left half of the body-cavity than in the right. The primary intestinal loops are so arranged or packed, that their bases begin on the right whilst their apices extend towards or into the left side of the abdomen. This is especially the case with those loops which starting to the right of the stomach (itself mostly shoved to the left) fill the space between stomach and vent with their distal halves. It needs no further comment that it is the free or apical end, and not the base of a loop where the mesenteric vessels enter, which is displaced easiest and which will easiest resume its original position. But this packing from right to left is not an adaptation to, and is not produced by the preponderance of the left oviduct. It can be traced to a much more primitive condition, namely to the fact that the bird's embryo comes to rest with its left side upon the yolk, with its curved back towards the blunt pole. In all probability this is a truly cænogenetic feature, essentially ontogenetic; one of those numerous phenomena which, like the gills of tadpoles, the allantois and placenta, are originally incidental to embryonic life, although they may by correlated after-effects profoundly influence even the adult organism. Obvious results of this left-sided position of the embryo are the increasing preponderance of the left vitelline vein; the yolk-stalk causes the first loop of the midgut; the stomach itself sinks in, turning the pylorus to the right, upon which side the duodenal loop descends, and further secondary loops of the midgut follow suit. If there are large cæca, they likewise make their way towards the right and back of the stomach. The allantoic bag, containing fluid only, rises and comes to lie upon the embryo, *i. e.* upon its right side.

Consequently there is asymmetry introduced at an early date, which affects the viscera, notably the gut, and introduces a bias in their mutual behaviour within the belly. During the growth of the embryo, by shrinking of the yolk room becomes available for extension of the gut towards the left side. The permanent organs will soon—speaking from the point of evolution—establish an equilibrium, whilst it is clear that any occasional or contingent requirement of space, or disturbance, can be met with easiest in the left half. Such a disturbance is caused by the periodic growth and passage of the eggs which brook no delay. The slightest bias will turn the scales, and now we may apply the censorship of natural selection to its fullest extent. Left eggs

\* The suppression of the right oviduct has had an effect upon the male copulatory organ. Where such is present it is asymmetrical, although unpaired, and stowed away in a left-sided recess of the cloaca. The act invariably takes place from the left side, and the same applies to those birds which are now devoid of such an intermittent organ.

and a left duct will be the least liable to set up complications. Two canals may be good, but one improved way is better, and if the traffic goes in one direction only, the other duct falls into abeyance. If goods are still produced at the terminus of the obsolete line, they will deteriorate, but this does not matter if the output of the opposite factory is equal to the demand.

So far so good, and the enquiry need not be carried further back, if it were not for the Monotremes. Although these archaic creatures show no appreciable difference in the size of their paired ovaries and ducts, only those of the left side are functional. According to Semon, *Ornithorhynchus* invariably produces two eggs, always in the left side; *Echidna* lays only one egg, also left-sided. The right ovary forms numerous large eggs which never ripen, and the respective duct and uterus are swollen and much vacuolised during the season. In short, Monotremes behave exactly like certain abnormal birds, *e.g.* the famous Sparrow-hawk, by the retention of an ancestral feature which is now normally lost. Since the reduction in the Monotremes has made so little progress, it looks as if it were but of comparatively recent date, but at the same time so ancient as not to have interfered with the inheritance of the full symmetry by the Meta- and Eutheria. The Monotremes are no longer quite primitive, not even in these organs. Their eggs have lost much of the yolk; they continue to grow in bulk within the uterus after they have received their keratine shell. Indeed, we cannot well imagine that, compared with oviparous reptiles and birds, the very small egg of the Monotremes, and the imperfect, almost larval condition of the new-born represent truly ancestral conditions, unless—and this is well worth further enquiry—we are prepared to assume that in all Vertebrata the viviparous condition was primary to one in which the fœtus is surrounded by a shell and then hatched outside the mother. If this should be the case, we should further have to distinguish between primordial viviparity (of which recent examples are unlikely) and secondary, pseudo-primitive viviparity, the numerous instances of which have been, and are still being, acquired independently: many Sharks and Teleosts; many Urodela, even one or two of the Anura, and many scattered cases among the reptiles, as some Chameleons and Lacertidæ, Iguanidæ and Anguidæ, all the Scincidæ, all the thoroughly aquatic snakes, the Viperidæ, and here and there some other terrestrial kinds. But to return to the Monotremes. Can their incipient, or perhaps arrested, asymmetry be referred to the same embryonic conditions as those which prevail in Birds? The bulk of the egg is formed by the yolk, the yolk-stalk might be strong enough to cause a disturbance, the allantois protrudes towards the right, and the left vitelline vein preponderates. How far, and if at all, the viscera are affected by these conditions, remains unknown. For our purpose it is significant that there is incipient asymmetry (functional although scarcely structural), and that this should be restricted to the only recent Mammals

which still possess comparatively large-yolked eggs. However, the Monotreme embryo does not turn upon its left side, it merely sinks into the cavity of the emptied yolk-sac, forming a proamnion; the bird, owing to its enormous yolk, turns over and ultimately comes to lie on its curved back; the reptilian embryo must also sink in, but it does not turn. This turning over, so marked a feature in the bird, may be correlated with the conditions of incubation. Everybody knows that the chalazæ keep the blastoderm "on the top," *i.e.* nearest the source of warmth, against the hen's body\*. This does not apply to reptiles which deposit their eggs in the ground, nor to the one or two eggs in the moist pouch of the Monotremes; lastly, to the embryo of viviparous and ovoviviparous creatures "orientation" towards the source of heat is not only unnecessary, it would also be impossible because the mother changes so much her own position by moving about.

Since no trace of functional asymmetry of ovaries and ducts appears in Meta- and Eutheria, and as that of the Monotremes cannot well be a reptilian inheritance (because their asymmetry is usually marked by an enlargement of the right gonads and ducts, *e.g.* Snakes and Crocodiles, both sides however being functional), the asymmetry of the Monotremes must be due to a departure within the Prototheria, but so slight as not to have caused any irreparable morphological reduction of either ovaries or ducts by the time that the Prototheria entered upon the next higher or Metatherian stage, excepting of course the Monotremes. If Prototheria ever laid eggs much larger than they are now, the asymmetry may have been greater and be referable to the same primary causes as those suggested for birds, but since the recent Monotremes seem to be actually in the process of reducing them now, and moreover to the last possible number, the left-sidedness seems to be a case of mere coincidence with birds.

Some simplification of the completely double female apparatus of the Vertebrates was bound to come; it was a matter of time, and success depended upon the grade or height of the general organisation of those who attempted it. Any agreement between birds and mammals versus reptiles cannot be anything more than convergent resemblances, at best cases of Isotely. The classes of both Birds and Mammals have gone beyond the level of the Reptilian organisation and they represent highest termini; but, although the class of Birds is by far the most specialised and in various respects has reached seemingly unsurpassable perfection, the class of Mammals is morphologically the highest, in spite of its still comprising such lowly, undecided types as the

\* The usual statement that the hen turns the eggs over from time to time in order to ensure the equal warming of the whole egg, now the upper and then the lower half, implies nonsense. What the sitting bird does, is to rearrange the position of the eggs with reference to each other, to give those now lying peripherally an equal chance of best position near the centre. With a small clutch this is not necessary, but with a dozen eggs the frequent rearrangement is very noticeable, at least with thoughtful sitters.

Monotremes (*cf.* loss of the nucleus of red blood corpuscles, structure of the atrio-ventricular valves, the alveolar lungs, the abolishment of the cloaca, the cranio-dental articulation of the underjaw, etc.).

The Elasmobranchs show various instances of precocious inventions, ahead of the times, foredoomed to failure or further improvement, because their owners are after all but low fishes. In some the ovary is single, unpaired, but it lies in the middle. Some Acanthopteri have succeeded in producing a median duct out of their otherwise paired ovarian sacs. Birds, as we have seen, have suppressed one side; a clumsy mode of procedure because it has a lopsided result and implies the reduction, by neglect, of one of the precious gonads. It is only the higher-graded organisation of the Mammals which has succeeded in simplifying the apparatus in the morphologically neatest way, namely, by the partial fusion of the two ducts into one passage, not only unpaired, but median, whilst the upper ends and the ovaries remain intact and functional.

Monotremes, Marsupials, and Placentals form an unbroken, progressive, therefore most probably monophyletic series. The reduction in question could not be brought about until the reptilian plan of hard-shelled eggs had given way to internal gestation. The differences between oviparous, ovoviviparous, implantally and placentally viviparous, are questions of degree only. There is for instance no difference, to be expressed in a few words, between the ovoviviparous fruit of a Viper and the newborn fœtus of a Kangaroo, except that the newborn reptile is complete and must shift for itself. The point is that the young bursts its egg, and other membranes, with the act of birth. Whilst no newborn reptile requires maternal care, most birds do, and all mammals are absolutely dependent on their mothers for nourishment.

Within the Class of Birds every stage from almost reptilian to practically mammalian conditions is represented. The typical nidifugous birds are hatched with still a considerable amount of yolk slipped into the belly, sufficient for the little ones to hold out for days without food until they are bodily and mentally strong enough to feed themselves; in many cases they have to be shown by the parents how to do it. Next come those which are hatched in a more or less helpless condition and must be fed by the parents with food either in its natural state or already semidigested. Lastly, those which are nursed with a milky secretion of the crop. The higher Altrices or Nidicolæ are born with but small remnants of yolk left, the digestive organs having been hurried on at the expense of the others. The most significant point, however, is that through the crop-secretion the Pigeons have established a parallel with the Mammals in so far as the young are fed actually with parental matter, in which proliferation and fatty degeneration of epithelial cells plays a great part. The analogy can be carried still further, since by

Pigeons and some of the lower mammals this "milk" is squeezed or injected into the young.

The Mammalian evolution has probably gone through many stages and vicissitudes, difficult to enumerate, because there were many factors and not all the organs changed at the same time.

1. We start with a hypothetical stage of Sauro-mammalia. The hard-shelled egg, when laid, contains an already far advanced embryo, therefore ovoviviparous. This egg was not so much incubated for warmth as covered for protection by the mother. The young although hatched in a reptilian condition was protected by the mother.

2. Reduction of the size of the egg. Gradual preponderance of extra-uterine nursing over uterine gestation, made possible and introduced by the protecting insulation, in such a way that an abdominal incubation area was developed, owing to the reaction of the mother's abdominal surface by the sat-upon, adpressed, covered egg; this resulted in hypertrophic condition of the cutaneous blood-vessels, hence of the glands, and correlated reduction of hairs. Incidental change of absorption of moisture through the porous shell, enhanced by loss of its calcareous portion.—When this suppression had been well established, by progressive inheritance, the now quite porous parchment egg had the same chances of absorbing fluid whilst still in the oviduct. At the same time it stands to reason that the chances of external or brood-pouch nourishing may become prevalent. The shortening of the life-period within the egg implies the birth of an unripe foetus. Foetal life must be taken as ending with the bursting of the egg, no matter whether this act coincides with the moment of parturition, or whether it happens some time after the egg has been "laid." In either case it coincides with the cessation of any further possibility of function of yolk-sac and allantois.

We must further assume that the actual length of time required for the production of a young animal is the same in equal-sized creatures from the beginning of segmentation until it is independent. Unless we assume this, the argumentation would become too complicated.

Let us say that it took 50 days from impregnation until the Sauro-mammalian youngster was ready to face the Permian world. This means:

50 days of ovoviviparous, internal uterine life .....	(Sauro-mammal).
40 days uterine and 10 days incubation-life within the laid egg.....	(Hypotheria).
30 " " 10 " " and 10 days nursing in pouch	(Prototheria).
20 " " 5 ? " " 25 " "	(Monotremes).
8 " " 0 " " 42 " "	(Opossum).

The suppression of the incubation-life marks the Metatherian stage just as sharply as the introduction of incubation of a foetus marked the early Mammal stage. The adaptation to the

new invention of pouch-life and nursing caused the development of an entirely new category of features --of features which were not required either by the fetus or the adult, therefore *larval*, e. g. a suckorial apparatus with its far-reaching incidental influences upon the future adult structures.

In these respects viviparous reptiles, Hypo- and Prototheria culminating in Monotremes, and Metatheria culminating in Marsupials, represent a continuous progressive series, with a logical terminus characterised by the enormous preponderance of extra- over intra-uterine development. Compared with these terminal Marsupials the Eutheria seem to be totally different, provided we take as their type those which are born complete, in this respect like the hypothetical Sauro-mammals, the whole of the "50 days" being intra-uterine. And yet the Eutheria have with certainty passed through the same Metatherian stage as have the Marsupials, and this Metatherian stage comprised, besides others, the following features\*: Truly viviparous; allantoic placenta; marsupium; diphyodont teeth, the same two middle series of a total of prelacteal, lacteal, permanent and post-permanent sets; nipples; semi-cloaca; absence of a corpus callosum.

To arrange any one of these features into successive morphological stages is comparatively easy, but it does not follow that these represent exactly the phylogeny of the groups, because of the complicated correlations with other organs which by no means keep step with each other, neither in the same species nor in the greater groups. Some are precocious, even hypertelic, while others lag behind.

Just as to the large egg of the truly oviparous Sauropsids albumen (more watery but less fatty yolk) is added, before it receives its calcareous shell, so in the Monotremes fluid is added to the contents of the egg, but with the remarkable difference that fluid matter is taken into the yolk-sac itself by osmosis from the uterine walls, *after* the keratine shell has already been developed. This process is correlated with an undoubted previously acquired reduction of the amount of ovarian yolk, and is as much a secondary process as the loss of calcareous matter in the parchment-like "keratine" shell.

As Semon has shown, the whole shell-enclosed egg multiplies its size during its passage through the oviduct. This mode of growth finds a curious parallel analogy in various Lacertilia, the parchment-shelled eggs of which grow considerably after they have been deposited.

Whilst the Sauropsidan allantois comes to surround the whole yolk-sac and also nearly the whole of the albumen, so as to spread over most of the inner surface of the egg, the Monotreme

\* Cf. R. Semon: "Monotremen u. Marsupialier," in Zoolog. Forschung. Australien, ii. 1894-97; further, J. T. Wilson and J. P. Hill's papers in Q. J. M. S. 1897, 1898, 1900.

allantois and yolk-sac balance each other. The shell-enclosed egg is for a short time transferred into the marsupium (*cf.* Semon, *Echidna*; not into a bursa as was imagined by Klaatsch, Gegenbaur, and others), which secretes fluid (the "nutritive sweat" in Gegenbaur's unfortunate diction), and this can be taken up by the embryo through the porous shell. This may be the reason why the shell is soon cast off.

In Marsupials the shell is at first still present, but soon absorbed within the oviduct. The egg-membranes, etc., of the embryo establish no structural communication with the uterus. The ovarian yolk is much reduced. But the yolk-sac becomes enlarged, as in the Monotremes, still occupies a great portion of the inner egg-surface, and has established intimate contact with the serosa. The allantois, being independent of the expansion of the coelom, which results in the driving away of the yolk-sac vessels from the somatopleure, establishes a villous placenta. Such must have been the condition of the Metatheria.

In *Perameles* the allantois still reaches the surface, where it is very vascular, and fused with the serosa, a truly respiratory arrangement. The placenta being lost in most other Marsupials, the allantois reverts to its primary function of urinary receptacle, although apparently late during the foetal life.

The Metatherian stage may therefore be characterised as one in which the posterior of the two bags, the allantois, has superseded the previous attempts of placentation by the yolk-sac. The new placenta was perhaps not advanced enough to prevent the foetus from being born soon after the limited amount of yolk was used up. Certainly it did not pass beyond the non-deciduous stage, and it never reached the extent of even the lowest recent Eutherian placenta. Yet one effect of this incipient organ must have been to render the foetus less independent than that of a viviparous reptile. It had therefore still to be transferred into the marsupium, there to be kept moist and suckled in as premature a condition as the Monotreme.

Two opposite tendencies are inherent to this stage. One palingenetic, to give birth when the yolk is used up; the other cœnogenetic, to prolong the retention of the foetus because of the compensatory, respiratory, etc. advantages incidental with a placenta. Obviously the Metatherian stage was a half-way house at a parting of the ways to further improvements, leading to Marsupials\* and to Placentals.

\* We have here an instance of the well-known fact that Group-names based upon single anatomical features are mostly unsuitable for classificatory purposes. The taxonomic value of these characters may be good enough, but they are not diagnostic. If such names were used merely as labels without much intrinsic meaning, well and good, but even the best of us cannot, on occasion, resist taking their face-value for full value. There are Mammalia Implacentalia with a placenta, and we now know that the young *Echidna* does not lie in a bursa. *Odontornithes* are a valueless, heterogeneous assembly, and overconfidence in "*Ratitæ*" was responsible for having branded *Hesperornis* as a "swimming Ostrich." "*Mammalia*" is fortunately an excellent term, although invented before Monotremes were known.

To judge from analogy the new organ should continue straight on, leading in this case through a diffuse and cotyledonary to a solid, and from a non-deciduous to a deciduous placenta, terminating in the birth of the young in an utterly helpless condition. As a rule the non-deciduous and diffuse placenta is found in those mammals which at birth require least maternal care. The latter implies greater mental capacity. But we also know from analogy that a recent invention—although it may be capable of much perfection—is not always kept up if the old string to the bow is still capable of further adaptation. Where both alternatives are good, workable, and capable of being improved, it may take a long time to settle which is after all the better of the two.

What has induced some Metatheria to neglect the further development of their placenta and to intensify the marsupial alternative? The morphological and physiological momentum was surely on the side of improving placentation. There must have been some external, environmental influence, and it was Dollo's brilliant suggestion that arboreal life was the underlying cause. His further explanation is less acceptable, that the climbing habits have caused premature births, which have become habitual, and that the hapless fœtus had therefore to be nursed and located in a marsupium, the bursa, or rather multiple bursæ, being no longer sufficient.

I think the new conditions to be faced by intense arboreal life have acted somewhat differently, especially if, as we assume now, all the Metatheria were already possessed of a marsupium\*.

I venture to suggest that those Metatheria which were driven to arboreal life, had to solve the question what to do with their young. They had to carry them, and being already possessed of the pouch, this was not only retained but intensified by prolonged use. That the facilities offered by such a pouch are great, is shown by the still existing numerous and much diversified Marsupials, and by the fact that some at least, *e. g.* Opossum, have reduced the uterine gestation almost to the conceivably lowest limit. Whilst these arborealised Metatheria could not afford to leave their young behind, it was different with those other Metatheria which during the Cretaceous epoch somewhere "in the larger and more effective workshops of the North" (to apply here one of Darwin's happiest expressions) went

\* Klaatsch's view of the correlation between Bursæ and Marsupium had to be considerably modified by Semon's discovery that the Monotreme does not lie in a bursa but in an already typical, though transient, marsupium. Moreover, there are unmistakable vestiges of marsupial muscles, other than compressores mammae, in various Placentals. Lastly, each teat with its areola does represent a bursa (Klaatsch), but if each bursa had been a brood-pouch instead of merely the result of the attachment of young, the possession of a series of bursæ from near the vulva up to the armpit would imply an impossible condition. In fact, bursæ or nipples can be formed independent of a marsupium and in places whereto no such organ can have extended.



in for that further mental development which is intimately correlated with the origin of the corpus callosum. Competition is most effective if backed by brain-power. Where these dawning Eutheria spread the other Metatheria had to go to the wall, or were forced to get out of reach—into the trees. Those which, already arborealised, found their way into countries like Australia, where the Eutheria could not follow in time, found there nothing to prevent them from becoming again terrestrial, as Dollo has shown so conclusively. The chance of reviving the degenerated placenta was, however, gone, and the Marsupials are now, in spite of the retention of various low characters, the most specialised subclass of Mammals.

The Edentates present a striking analogous case: being without exception arboreal or fossorial, they also seem to have got out of the way of mentally higher, dangerous Eutheria. They have survived, whilst those that went in for heavy bulk and armour were not a great success. At least the American Edentates seem to have come into contact with the dangerous Eutheria long after they themselves had become typical Eutheria, so that the former possession of a marsupium could avail them nothing.

A few words about the Eutheria. They could afford to part with their young for a time and to suckle them intermittently, an advantage which needs no further comment than that it would be impossible without higher mental faculties.

Great adaptive changes have been wrought; every chance has been tried, now here, then there. Nearly all the Non-deciduata are at birth precocious, able to look after themselves, no matter whether the placenta is diffuse, cotyledonary or zonary even, namely the aquatic Cetacea and Sirenia, and the Artio- and Perissodactyles, the exception being the Lemurs. The Deciduata are at birth helpless: Rodents, Insectivores, Carnivores, Chiroptera, Tarsius and Simiæ, except the Elephants.

The egg-laying Monotremes, the implacental Marsupials, and the Mammals with the most advanced placenta, are born in a condition as helpless as the highest nidicolous birds, whilst the avowedly low non-deciduous and diffuse placenta of the Mare i sufficient to produce a young which is as precocious and independent as a lizard.

Can these facts be brought into line? What is here primitive and what is a roundabout return to apparent but not really ancestral conditions?

49. Contributions to the Anatomy and Systematic Arrangement of the Cestoidea. By FRANK E. BEDDARD, M.A., D.Sc., F.R.S., F.Z.S.; Prosector to the Society.

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(Text-figures 113-121.)

- VI. ON AN ASEXUAL TAPEWORM FROM THE RODENT, *Fiber zibethicus*, showing a new form of Asexual Propagation, and on the supposed Sexual Form.

#### INDEX.

	Page
Structure .....	825
Systematic :	
<i>Urocystidium gemmiparum</i> , gen. et sp. n. ....	840
General Résumé and Systematic Position .....	849
Anatomical Summary .....	850

I received in February of this year two complete tapeworms which were found in the hepatic duct of a Musquash (*Fiber zibethicus*) which died in the Society's Gardens. The two worms lay together in a part of the hepatic duct just before it receives the bile-duct, which was much dilated by the parasites. Although these two worms were very different in appearance, I believe them to be respectively the sexual and asexual form of the same species. I shall give reasons for this conclusion in the course of the following description of the two individuals.

#### (1) THE ASEXUAL FORM.

The general appearance of this very remarkable worm is shown in text-fig. 113 (p. 824), which illustrates its most remarkable peculiarity, viz., the possession of two series of what appear to be buds at one end of the body. It will be seen in the course of my description of this "Cysticeroid" that it is without any doubt to be regarded as an asexual form. It does not, however, follow that the mature worm found with it is a further stage in its development. On the contrary, indeed; for as a mere matter of guesswork, the assumption would be the other way. Still, I believe that I shall be able to prove that the two worms are stages of the same species, in which event we have the very remarkable fact of both the sexual and the asexual form coexisting in the same host, and, moreover, in a situation where one would expect to meet with sexual forms only. The *Hymenolepis*\* of the mouse is a partly, but not an entirely, parallel instance.

At first it seems likely, from an inspection of the figure

\* *H. murina*,

annexed, that the wider end of the worm is the scolex and that the narrower end is the posterior extremity where the proglottids are being shed. The dilated extremity suggests a scolex not altogether unlike that of the genus *Dasyurotenia*, which I have lately described to this Society\*, and which is characterised by an unusually swelled scolex. Furthermore, there is a slight diminution in the diameter of the worm towards the narrower end, which again conforms to this view, which, as a matter of fact, I at first held myself. It appears, however, that the reverse in fact is the case, and that the narrower end is the scolex end. The opposite extremity therefore is, as I suppose, to be compared to the persisting bladder of the bladder-worm stage of the Cestode. To the naked eye, and even on examination with a lens, the scolex end presents every appearance of being the proliferating end of the body, for the last segments appear to be slightly incurved, as is so commonly the case at that end. It was not until I studied this region by means of a series of horizontal sections that I was able to discover its true relations. And even now certain important details are wanting.

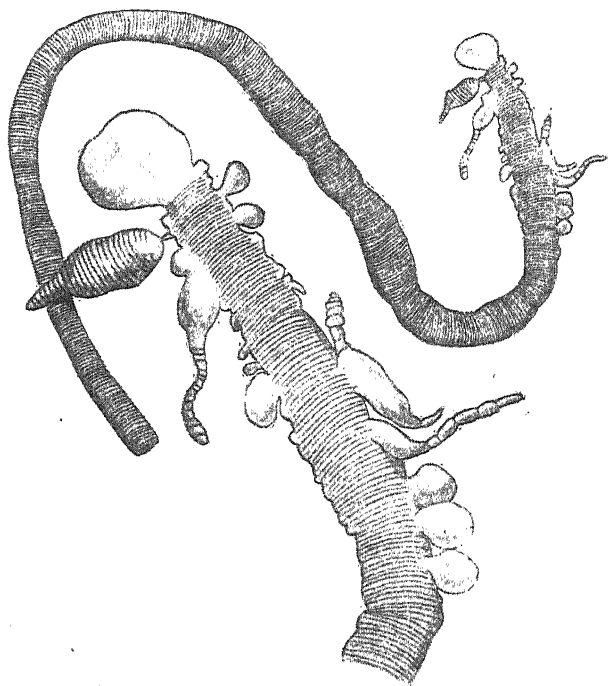
I could find, indeed, no armed scolex, nor any trace of suckers; if the worm is a member of the Pseudophyllidia and has therefore only bothria, these may easily have escaped attention in such sections, which would not be suitable for their display. I cut the sections, in fact, under the impression that I was dealing with the posterior end of the body, and without making a sufficiently exhaustive survey of the external characters. The main arguments, therefore, which lead me to the conclusion that this is really the scolex end are firstly the mode of imbrication of the proglottids, and secondly the presence of large pigment granules, a condition which would hardly be expected at the posterior end of the body, but which is not uncommon among tapeworms in the scolex. As to the imbrication of the proglottids it seems to me to be necessary to regard a segment which overlaps the next one as being anterior to it in point of origin, and therefore lying to the scolex side of it. Judged by this conclusion, the narrower end of the body of this very remarkable tapeworm is the scolex end.

There is no evidence that a scolex has been lost. On the contrary, the body ends here in a slight median elevation, which is quite unlike the termination of the body were this the region of the detachment of proglottids. This little elevation, however, bears no particular likeness to a scolex, and there are certainly no suckers or hooks to be seen anywhere. Nor is there any neck, or break of any kind, between this region and the first obvious proglottid. In this latter, moreover, the lateral and transverse tubes of the water vascular system are as large as in the more posterior segments, and do not end in a coil such as is so frequent in the anterior part of this system in other worms. It may be, of course, that the scolex is in this genus a transitory affair, as it has been

\* P. Z. S. 1912, p. 677.

believed to be (though perhaps hardly now) in certain other tape-worms. Or, on the contrary, we may have here a feebly developed head like that of *Ligula*. But the great breadth of the body of the present worm is not perhaps in favour of such a supposition. Had there been a very narrow anterior neck, some suggestion of this kind might have been put forward. Anyhow, the general characters of the anterior region of the body of this Cestode are as described above. We shall recur to their more minute anatomy

Text-fig. 113.



The upper figure represents the entire asexual form of *Urocystidium gemmiparum* enlarged by about one-third. The lower figure is the posterior end of the same individual more magnified. For explanation see text.

later. From this point to the extreme posterior end are very many proglottids. They are very short and wide, and do not appear to differ very appreciably in length in different regions of the body. The greatest diameter is something like 4 mm. This is at and towards the posterior end of the body. Quite anteriorly, the diameter is not more than 2.5 mm. The length of the entire worm is about 80 mm.; the small posterior bladder is 3 mm. long

by 2.5–3 mm. wide. The proliferating end of the worm ceases abruptly with the commencement of the bladder. This region, which bears a great many lateral buds, shown in the text-figure referred to, measures 17 mm. The region of the body which bears these presumed buds (we shall consider their nature later) does not differ much from the preceding section. It looks, perhaps, a little more transparent, but it is divided up exactly in the same way into proglottids, which are of about the same dimensions as those elsewhere in the body. The buds form a row on each side of the body and are quite lateral in position; they are not at all arranged in order of growth, though representing very many stages. That is to say, the older buds alternate with younger and older forms. Nor does every proglottid bear a bud or pair of buds (one on each side). Between any two buds there was often a variable number of proglottids without any trace of budding at all. This, indeed, is necessary; for the large size of the buds would prevent their proper growth upon immediately adjacent proglottids. I counted altogether 17 buds upon one side and 18 upon the other. But I may have omitted one or two in each case; for it is a little difficult to fix the actual first appearance of a bud. They begin, in fact, as an only just recognisable rounded swelling of the edge of a proglottid. Sometimes the swelling includes two proglottids. There is no question whatever of the continuity of these buds (as I regard them) with the parent stock; they are most plainly outgrowths therefrom. In later stages the minute round bosses at the edges of the segments swell into spherical, largely transparent, vesicles, of which, as the text-figure (text-fig. 113) shows, the size varies—possibly according to age. Later still, these bladders show a young worm growing out from their distal extremity, which is usually of considerably less diameter than the bladder which is attached to the parent stock. It exhibits numerous wrinkles which I do not definitely regard as the delimitations of proglottids. The longest of these presumed young worms was about 4 mm. in length; the bladders reached a length of 2 mm. The exact number of these more developed buds is faithfully reproduced in text-fig. 113.

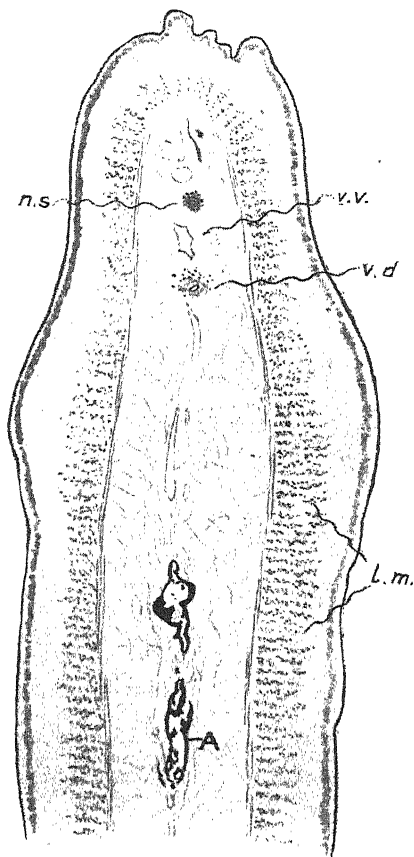
#### § *Structure of the Parent Stock.*

I have investigated the anatomy of the worm by transverse, longitudinal, and sagittal sections. From an inspection of the former (see text-fig. 114, p. 826) the depressed form of the body was obvious, the diameter of a section being about seven times its depth.

At the thinner anterior end of the body, not far from the actual extremity, transverse sections showed that the medullary region of the proglottid was not more than two-thirds of the diameter of the cortical region. The two were plainly marked off from each other by delicate transverse fibres forming a very thin layer, and

yet quite unmistakable. The same proportions and the same structure were visible as plainly in the wider posterior region of

Text-fig. 114.



Part of a transverse section through a proglottid of the asexual form of  
*Urocystidium gemmiparum*.

- A, spaces in middle of proglottid with darkly staining walls referred to in text.  
l.m. Longitudinal muscular layer of cortex, within which is seen delicate transverse layer of muscles. n.s. Nerve-cord. v.d. Dorsal excretory tube, v.v. Ventral excretory tube.

the body. The medullary substance is quite well stained by hæmatoxylin and has the usual homogeneous appearance. There is,

moreover, in the present worm the usual meshwork arrangement of fibrils round spherical masses of the homogeneous ground-substance such as occurs in so many tapeworms, and is often a very coarse and thus more obvious network. The homogeneous ground-substance was, however, traversed by two sets of fibres, which are, I presume, muscular fibres. These are absolutely at right angles to each other and not at all closely set in either case. The dorso-ventrally running fibres are nearly always wavy in their course, the transverse fibres are quite straight—a matter of different states of contraction, as I imagine.

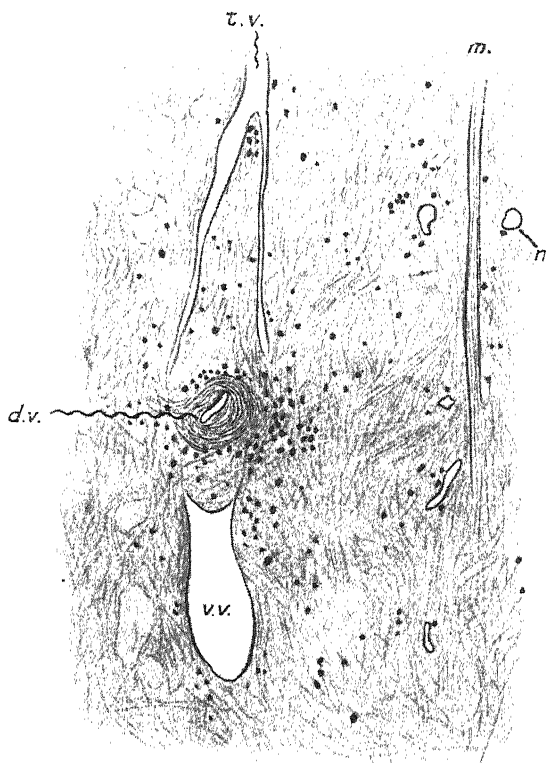
The cortical layer is easily divisible into two regions, which are of about equal diameter. The innermost of these is that occupied by the bundles of longitudinal muscular fibres. The bundles of muscular fibres are two or sometimes three deep, and each bundle contains a large number of fibres, which, however, are not very closely pressed together. In addition to these bundles of rather slender fibres there lie on either side, between the nerve-cord and the lateral margin of the proglottid, two bundles of considerably stouter fibres which run continuously from segment to segment and are closely associated with a longitudinally running cavity. These bundles appear on occasions to lie actually within the cavity. This tubular cavity is not at all like the tubes of the water vascular system, and it lies within a very lax tissue. I am unable at present to suggest its nature.

The accompanying text-figure (text-fig. 115, p. 828) illustrates a section through the hinder part of the worm not very far in front of the budding region. This region shows very plainly a system of irregular spaces in various parts of the body belonging to the water vascular complex. It may be remarked first of all that the dorso-ventral diameter is greater here than in the more anterior part of the body. The structure of the vertical and medullary regions is the same, but the lower central region of the medulla actually forms a cavity (text-fig. 114 A) which I do not think to be artifact and which may be a forward extension of the cavity of the terminal bladder, though I have not proved the fact, from an unwillingness to sacrifice the specimen altogether. The interior lining of the space was, however, so very strongly stained as compared with the surrounding tissues that it appears to me to be practically certain that the staining fluid gained access through the two cut ends of the piece of worm, which was stained *en bloc*. This, of course, argues a continuous central cavity.

It was quite plain that this cavity was quite distinct from that of the transverse water vascular trunk. The peculiar central cavities occupying nearly the middle of a segment here and there, referred to later (see p. 830) in describing sections made from earlier segments in the body, are present here and are again not to be confused with the central lacuna. Their thick walls show no trace of an opening into it. In addition to the main trunks of the water vascular system, which are disposed here as they are elsewhere in the body, there are scattered irregular spaces which

seem to belong to the same system. These consist of larger but very short stems with finer branches. I have not traced any connection between these tubes and the main stems of the excretory system; but I can, nevertheless, hardly doubt that it exists.

Text-fig. 115.



A more highly magnified section through excretory vessels and adjacent structures of the asexual form of *Urocystidium gemmiparum*.

*d.v.* Dorsal vessels surrounded by circular muscle-fibre. *m.* Layer of transverse muscle-fibres separating the cortex (to the right) from the medulla (to the left). *n.* One of several tubes forming the excretory network and lying, as is shown, in the cortex as well as in the medulla. *t.v.* Transverse commissural vessel forking to join the ventral vessel (*v.v.*), which is also bifurcate to receive the branches.

These ramifications lie in the cortical layer as well as in the medullary (text-fig. 115, *n.*). In one case I observed a narrow duct leading from a wider space to the exterior—at any rate, most



undoubtedly to the cuticle, and in other cases it appeared to me to be highly probable that the ramifications of these tubes do open on to the exterior here and there; they at least invade the outermost layer of the cortical tissues.

The *water vascular tubes* are large in this species, and not far from being equisized. There are, as is the rule, two upon each side of the body. As is so often the case among the Cestodes, the two tubes, instead of being respectively dorsal and ventral and superposed, lie side by side. As is also quite usual among these worms, the two tubes, dorsal and ventral, differ somewhat in structure. I consider that the slightly smaller and more muscular of the two tubes is the dorsal vessel, from the analogy of other forms; in the present species, therefore, the dorsal vessel is situated internally to the ventral. They are, however, quite in the same straight line for the most part and also in the same straight line with the nerve-cord. But, as a matter of fact, the more muscular dorsal tube lies in a corkscrew fashion, which is very plain when the proglottids are viewed in longitudinal and sagittal sections, and thus that tube in cross-sections appears to lie now rather dorsal of, and at times rather ventrally of, the ventral and more external vessel. Elsewhere they are more directly in the same straight line. It is a remarkable fact that both of these vessels seem to be quite as large or very nearly so in the most anterior segments of the body. There is no great increase in calibre posteriorly.

The general relations of these two vessels are shown in text-fig. 114. Text-fig. 115 is a more enlarged representation of the two tubes and the adjacent parts taken from a section of the posterior region of the body. Their detailed structure is there illustrated. In his account of the Cestoidea in Bronn's 'Thierreichs,' Prof. Braun remarks—"Ob in der Wand der Sammelröhren auch noch Muskelfasern vorkommen, ist noch strittig." The figure just referred to is, as I think, quite conclusive as to the presence of a particularly thick layer of circular fibres constituting the greater part of the wall of what I regard as the dorsal vessel. This muscular layer appears to wax and wane in thickness from place to place. But it is always thick and thus very apparent. The actual tube is lined with a chitinous cuticle which is also often very thick and everywhere to be seen. Outside of the layer of circular muscles are abundant nuclei, massed round the tube. I did not observe any nuclei among the circular muscular fibres, which are, indeed, very closely contiguous. There appear to be no intrinsic longitudinal muscles to assist in the widening of the tube again after contraction by the circular muscles; but there is a mechanism which takes the place of such fibres to serve in their stead.

In the neighbourhood of the dorsal excretory vessel the dorso-ventral muscles form groups here and there of rather thicker and more closely adpressed fibres, which, as it were, tie to or suspend the dorsal vessel from the cortical layer; it seems certain

that the contraction of these would dilate the lumen of the dorsal excretory tube. These fibres, which exist both dorsally and ventrally, have a somewhat fan-like arrangement—that is to say, they converge upon the vessel from above and from below. It is these various muscular layers which cause so great a variation in the lumen of the excretory tube from place to place.

The ventral vessel differs entirely from the dorsal by the entire absence of any muscular layers and by the possession of only a very thin lining cuticle. It follows, therefore, that the variations in the calibre of this tube are not so great, and when they do occur seem to be due to a squeezing by the surrounding tissues. The ventral vessel also runs a much straighter course than the dorsal without any marked corkscrew-like windings exhibited by the latter. There is a transverse vessel in each segment which has a rather peculiar relation to the ventral longitudinal tube into which it opens on either side of the body. A little way before reaching the dorsal tube the transverse vessel splits into two halves, which embrace the dorsal vessel and open separately into the ventral vessel. This is partly shown in text-fig. 115.

We have now to deal with a series of sac-like bodies forming closed cavities of very problematical nature, which lie in the middle of many segments. There is by no means one of these sacs to each segment, and thus they are very far from constituting a tube running without intermission through the body. I compare them, however, later in this paper to a tube found in the young buds (see p. 833). But, as a matter of fact, one of these sacs may actually extend through two proglottids, so that there is a hint of a formerly continuous structure such as occurs in the buds. As a rule, however, they appear to be limited to a single proglottid, of which they occupy sometimes the exact centre, at other times pushed rather to one side. They lie close to the transverse water vascular vessel. I cannot find that these sacs have any connection with any other spaces. They appear to be perfectly isolated. The first of the series occurs very early in the body—if not in the very first segment. These sacs have a lining cuticle surrounded by a single layer of epithelial cells of which the borders between the individual cells are not clear. The nuclei, however, are very obvious and large. There are no muscle-fibres at all apparent encircling the sacs. They often appear crumpled in transverse sections, and occasionally seem to be Y-shaped. They are impossible to miss in a series of sections.

The only remaining characteristic of this worm upon which I am able to report is the structure of the “head” end of the body, which has been already briefly described above. In the place of a scolex there is a small projecting process, no larger than the rostellar process of many unarmed tapeworms. This arises from the middle of what may be termed, for the present, the first segment of the body, which is distinguished from those that follow by its rather less breadth and greater length. It would seem to

be really composed of two segments, if we consider the condition of the water vascular system therein. The two main longitudinal vessels of this system extend well forwards into this compound segment, and the outer ventral vessels are connected by two transverse vessels, thus indicating, as I suggest, the double nature of this apparently single segment. Towards the centre of the specialised anterior segment is a large group of deeply-pigmented oval bodies, which appear to be special pigment-cells. They are as large, or nearly so, as the calcareous corpuscles which are very abundant in this worm. In the middle of the concave anterior border of these two fused segments is quite a small conical projection, than which nothing else at all comparable to a scolex exists. There is no sign of any breakage at the summit of this which might suggest that a scolex had been accidentally detached.

It is a somewhat remarkable fact that these conditions (or, at any rate, something very near to them) occur in the genus *Dioicocestus*; for, as will be pointed out later, the genus with which I am concerned in the present paper shows some likeness to the Acoleidæ and even to the genus *Dioicocestus*, which is of that family. In *Dioicocestus acotylus*, Fuhrmann \* has described and figured the practical absence of suckers and the very rudimentary condition of the rostellum—a state of affairs which is not found in the other species of this genus. The figure referred to also shows—as I have described in my species—the absence of any marked diminution in calibre of the body at the head end. But it must be remembered that the *Dioicocestus* was a fully-developed sexual worm.

### § Structure of the Buds.

It now remains to consider the minute anatomy of these outgrowths and their nature. As to the latter query, there are, as it appears to me, only two alternatives. These outgrowths must be either "tentacles" of the nature of the processes known in *Hymenolepis villosus*, or young worms budded off from the parent stock. There is very little, if indeed anything, to be said in favour of the former view. It is true that a large outgrowth of the body to form a tentacle might have very much the same structure as the body, even to possessing branches of the excretory system and lateral nerve-cords. But there would hardly be a practical identity of structure such as I shall point out in detail later. Furthermore, the growth of processes of the body might be expected to be more regular than are these outgrowths (cf. text-fig. 113), and above all a gradual freeing of themselves from firm contact with the body, as shown in the figure, is precisely what we should expect with budding offspring, which, as it appears to me, is the obvious and only way to interpret these appendages of the fully grown worm.

\* Zool. Jahrb., Abth. f. Syst. Bd. xx. 1904, p. 181.

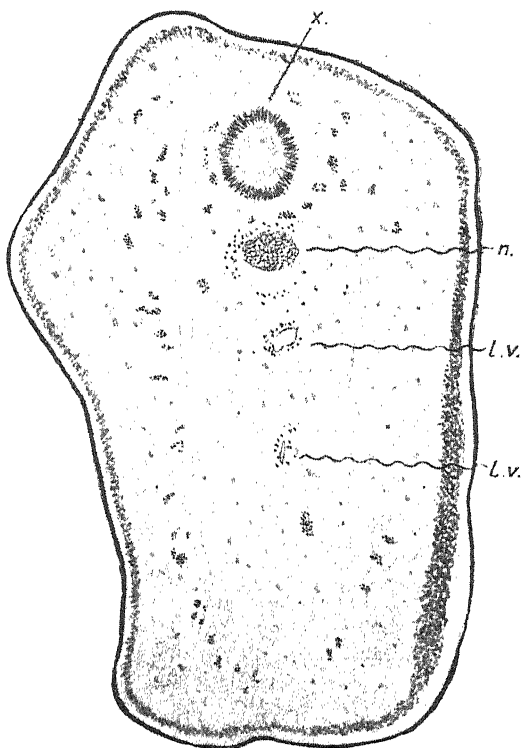
I selected for investigation, by means of transverse sections, the most adult-looking of the young budded-off worms, in which, moreover, segmentation was obvious. I have already referred to this individual in my account of the budding process and need not redescribe its external characters here. The wider end attached to the body of the parent forms a bladder with rather thick walls. This I take, therefore, to be the posterior end of the young worm. The opposite end is very much thinner (as is, of course, usual among tapeworms) and represents the scolex end of the animal. I could observe no trace of hooks anywhere on this scolex, nor suckers of any kind. This, however, is not surprising in view of what I have already described in considering the conditions observable in the parent stock. At about the middle of the worm a transverse section shows the appearances represented in text-fig. 116. The cortical layer is thick—about the same diameter, or in places rather more than the diameter, of the medullary region. The medullary region is plainly marked off from the cortical by transverse muscular fibres of delicate constitution.

There are several parallel fibres in this layer, which is altogether of some width, the individual fibres being widely separated. The parenchyma of the medullary region is as usual, and contains many nucleated cells, generally triangular in form, connected with processes at the angles. These cells get to be particularly numerous near the water vascular tubes, which will be referred to later. There are also heaps of nuclei visible in some sections, which I take to be the rudiments of the sexual organs. To one side of the body the medullary region seems at first sight to be invaded, as it were, by the cortical region, thus producing an asymmetry in the transverse section, which is quite apparent in the accompanying text-figure. This asymmetry is associated with the presence of a tubular organ (text-fig. 116, *x*), which will be described in detail on a subsequent page. This occupies a good deal of space, and round it are large bundles of stout muscular fibres, quite similar to those which occur in the cortical layer. It is very easy, however, to observe that the transverse layer of muscles bounding the medullary parenchyma is continued on either side of this differentiated mass of tissue and ends laterally at a point asymmetrical with its ending on the other side of the body. I therefore regard this region as belonging to the medullary part of the body. The cortical region is distinguished from the medullary (other than that section of the medullary region just referred to) by the bundles of stout longitudinally running fibres. These bundles form a layer immediately outside of the transverse fibres; but there are much smaller bundles and isolated longitudinal fibres extending some way towards the exterior of the body.

In the medullary region lie the water vascular tubes and the nervous system. All of these lie in the same straight line with each other and with the tubular organ already referred to, and

this line is the longer diameter of the cross-section; the tubes etc. are thus laterally disposed with regard to each other. It is necessary to emphasise what may appear to be a statement of the obviously true, since in other regions of the body the mutual relationships of these several organs and systems are a little changed.

Text-fig. 116.



Transverse section through middle of strobila of oldest bud of the asexual form of *Urocystidium gemmiparum*.

*l.v.* Excretory tubes. *n.* Nerve-cord. *x.* Tube of doubtful significance described in text.

In all other tapeworms known to me the water vascular tubes of the two sides of the body are symmetrical with each other in point of position within the medulla and distance from the lateral cortex on either side. They are also generally correspondent in size, though not always regularly so throughout the whole body. In the present species the water vascular tubes are asymmetrical in both these particulars. The tube of the one side is considerably

larger than that of the other and is relatively asymmetrically placed. This latter fact is doubtless due to the bundles of longitudinal fibres surrounding the large lateral tubular organ. This structure has, as it were, pushed the nerve-cord and the water vascular tube of its side towards the centre of the body. Indeed, the vessel in question lies very nearly in the actual centre of the section and quite in this position shortly before and during its connection by the transverse vessel with the tube of the opposite side of the body. These transverse vessels are at regular intervals and quite easy to see as in the adult worm. I did not observe any other branches of the water vascular tubes than these.

These sections from the middle of the body of the young worm also show very plainly the remarkable constitution of the nervous system in this Cestode. One of the two lateral cords (text-fig. 116, *n*) is very obvious indeed, lying between the water vascular tube of that side and the tubular organ of doubtful meaning. It cannot possibly be missed in these sections. But on the opposite side of the body I could find no trace whatever of any nerve-cord even of smaller size than the one represented in the text-figure. I feel confident that a failure to observe a cord in this situation, were it present, would be difficult. The medullary tissue is so clearly differentiated by the stain (iron hæmatoxylin\*) that the nerve-cord, if of any size at all comparable to that of the opposite side of the body, would stand out quite prominently. This state of affairs is undoubtedly very anomalous and hard of explanation. For we shall see later that the two nerve-cords are both quite recognisable towards the end of the body.

Finally, this transverse section shows to one side a large tube cut across, to which reference has been made incidentally once or twice already. It is situated in the centre of a group of bundles of longitudinal fibres, which bundles are like those in the cortical layer of the body in every way, including their rather sparse scattering round the centrally placed tube. The bundles in the cortical layer are not densely pressed together as they are, for example, in *Dasysurotania robusta*†. The tube itself is of considerable size and is lined by a thick layer of chitin, which is stained precisely like the chitin which covers the body of the worm externally. Outside of this is a single layer of stout longitudinal muscle-fibres, and then a deeply staining layer of elongated cells, interspersed among which are small bundles of stout longitudinal fibres. The structure of the tube is in fact almost exactly that of the outer layer of the body, only differing, indeed, by the intercalation of the groups of stout longitudinal fibres among the cells.

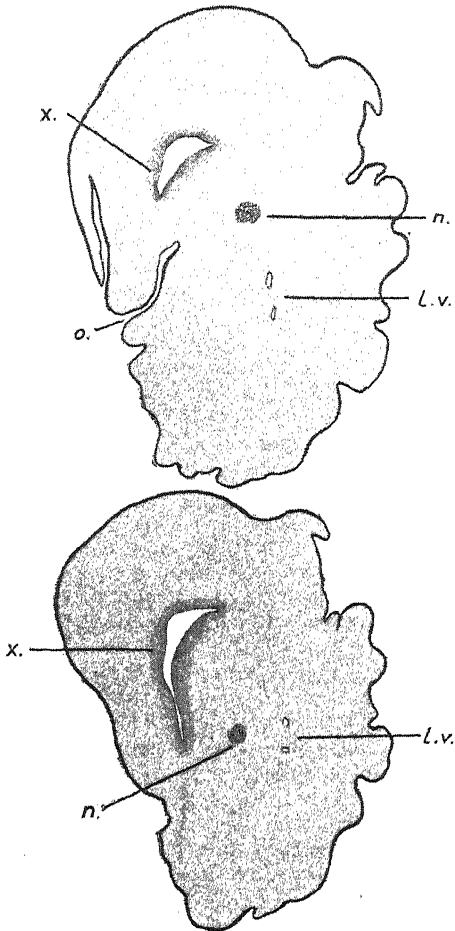
We shall now consider the course and structure of this tubular organ throughout the body of the young worm. The identity of structure with the outer layer of the body which this tube shows in the middle region of the body, is rendered intelligible

\* I am indebted to Dr. Plimmer, F.R.S., for the use of this reagent.

† See Beddard, P. Z. S. 1912, p. 684, text-fig. 97, *lm*.

by the fact that in two places, one behind the other, it communicates with the exterior by a narrow duct (text-fig. 117). One of

Text-fig. 117.



Two consecutive sections from another region of the same bud as that which is represented in text-figure 116, to illustrate the opening of the tube *x* on to the exterior.

In the upper figure the orifice (*o.*) on to the exterior is shown and the commencement of the invagination leading towards the tube *x*.

In the lower figure the outgrowth of the tube *x* to meet the invagination is seen.

*n.*, Nerve-cord. *l.v.* Water vascular tubes,

these openings is in the bladder region and the anterior one a very little way in front of this. Both orifices are dorsal or ventral\* in position—at any rate not lateral,—but they do not coincide exactly. In view of the position of these orifices it is clear that the tube of communication is of some length. In addition to these two openings on to the external surface, the tube gives off two short cecal processes, one of which nearly but not quite opens into the bladder.

Anteriorly the tube gradually comes to an end and does not end by opening on to the exterior. It diminishes in calibre for the space of a few sections and then simply ends. At the bladder end of the body—the end which is attached to the parent stock—the tube gets to be more and more shoved to the side as the bladder increases in size. In consequence also of this the tube becomes flattened from side to side, at the anterior part of the bladder. Followed backwards this tube can be recognised by its thick chitinous lining, already referred to, and can be seen thereby to be quite distinct from the excretory tube which has come to lie below it in consequence also of the development of the bladder region. The next that occurs is that the tube divides into two coincidentally with the formation of two or three septa, partly dividing up the cavity of that part of the bladder which lies adjacent. The two tubes lie one dorsally to the other, and thus both of them in the same straight line with the excretory tube. The middle tube of the two after a very short course appears to open into one of the chambers of the bladder, and is thus a diverticulum like the one mentioned above. Furthermore, I am not absolutely certain that it actually opens into the bladder; but it ends at least in close contact.

I feel, indeed, almost inclined to assert that this tube does open into the cavity of the bladder, since the main tube, continuing a little way further back, gets very narrow and undoubtedly ends by opening into the bladder. It is to be noted that these orifices do not involve a mere continuity of lumen. The character of the lining membranes changes at the point of meeting. It is further to be noted that it is not the main cavity of the bladder into which the tube opens, but into a portion of it, separated off by septa. This problematical tube varies in parts in its structure and in its relations to the nerve-cord. Anteriorly the layer of cells surrounding it are not so conspicuous as elsewhere, and thus the longitudinal muscular fibres come into greater prominence; the calibre of the tube also is not the same all through the body. It has been mentioned that in a section from about the middle of the body, that the tube lies outside of the nerve-cord and quite laterally to it. In other parts of the body, particularly anteriorly, the tube lies above (or, perhaps it may prove necessary to say, below†) the nerve-cord.

We have, therefore, in these young worms still attached to the

\* I cannot differentiate between the dorsal and ventral surfaces.

† See footnote above.



parent, though (as the narrow stalk shows) just ready for detachment, a tube of the structure of the outer layer of the body which traverses in a straight line nearly the whole of the body, which opens into the bladder behind and has two segmentally-arranged orifices of communication with the external world. There is no obvious answer to the question as to its nature. In buds within the cyst of *Echinococcus*\* a cavity is formed which is not an ingrowth of the cavity of the whole cyst, but which is alleged to be continuous up to the scolex. This, however, has been denied and the scolex asserted to be entirely solid. But even supposing a comparison is possible on the grounds that the scolex of *Echinococcus* is hollow, the short tubes leading to the exterior in the worm of which the present paper contains an account would seem to invalidate it. And, moreover, the structure of this problematical tube is not that of the bladder with which it communicates. It seems, indeed, to be a special structure and not a space connected in any way (or, rather, any *direct* way) with an evagination of the scolex.

For the greater part of the body I could only find a nerve-cord on one side, where it was quite as obvious as in the "adult" worm. In the anterior region, however, the nerve-cord of the opposite side was visible for a short space. It was, however, not half the size of its fellow, though of precisely the same structure and equally unmistakable as a nerve-cord. Both cords lie in the medullary region just at its bordering on the cortical layer. I could find no enlargement of the nature of a brain. Quite anteriorly, as well as posteriorly in the bladder region, I could not recognise a nerve-cord. It is noteworthy that the asymmetry of the two water vascular tubes in size is exactly paralleled by that of the two nerve-cords.

These are the facts which I have ascertained in the anatomy of the most mature of the growing buds. It now remains to compare the structure of the young worm with that of the parent stock of which it is a bud.

#### § *Comparison of Bud with Parent Worm.*

In the general form of the body and in the possession of a relatively small bladder they agree; also the rudimentary scolex is a marked feature of both young and old.

It is rather remarkable to find asymmetry in the young worm, but this of course may be its normal method of growth. Certainly I noticed no asymmetry in the parent form. What is perhaps important as a difference is the presence of only two water vascular tubes in the young and four of these in the older worm. The additional water vascular tubes may, however, make their appearance later. Furthermore, for the same reason, too much stress cannot be laid upon the more copious

\* Bronn's Thierreichs, iv. Abth. 1 B, p. 1549.

bundles of longitudinal muscular fibres which are to be noted in the large worm. I believe also that the continuous large tube in the immature worm is represented by the cavities contained in many of the segments of the adult worm, though the minute structure, it must be confessed, differs in the two cases. Furthermore, the series of cavities in the adult worm lie very nearly in the middle of the body, indeed quite in the middle of the body in some segments; the tube in the young worm is, on the other hand, as distinctly to one and the same side. But it must be borne in mind that the position does vary in the young worm, and a further flattening of its body might easily cause a greater similarity in the position of the tube to that observable in the more fully mature worm.

§ *Comparison with other Forms and Systematic  
Position of the Parasite.*

Apart from the question of proliferation by budding, to which we shall return later, this Tapeworm presents a certain number of undoubted resemblances to *Cysticercus fasciolaris* (of rats and mice, etc.), which becomes *Tænia crassicollis* in the Cat. Both these forms agree (I have compared the species which forms the subject of the present paper with examples of the *Cysticercus* from the common rat) in possessing a long segmented body and a small bladder posteriorly. But in *Cysticercus fasciolaris* the bladder is smaller and the body shorter than in my species, while the hooked and suckered anterior end renders any confusion or detailed comparison impossible. Nevertheless, the two forms have in common the small bladder and long strobila. But while the one occupies the position in the body of its host of a sexual worm, *i. e.* in a diverticulum of the alimentary tract, the other is found, as are *Cysticerci*, encysted, and in the liver of its intermediate host. Nor is it by any means certain that the species from the Musquash is a member of the Tænioidea (Cyclophyllidea) at all. It may well be a member of one of the lower groups of Cestodes. We shall consider the arguments for and against the placing of the worm among the Tænioidea.

It must be admitted at once that there are no absolutely conclusive arguments which point definitely one way or the other. This, of course, may be explained on the assumption that we are dealing here with quite a new type of Cestode. In the meantime, the structure of the worm so far as it can be read does not favour such an assumption, though it does not, for the matter of that, appear to be necessarily contradictory of this possible view. As to the other alternatives, the absence of a marked scolex with suckers is greatly against the reference of the worm to the Tænias, but the character of the terminal bladder, on the other hand, is on the whole in favour of such a placing. This latter fact is obviously against the supposition that the worm is a Plerocercoid of any kind; but the lack of a definite "head" is as clearly in favour of

this supposition. There, as it appears to me, the question must be left—in regrettable uncertainty.

The process of asexual reproduction by budding which this worm shows is not entirely unknown among the Cestoidea, but there are some not unimportant differences from what has been recorded in other forms. There are two principal comparisons to be made.

The first of these is with *Cysticercus longicollis*, the bladder-worm of *Tenia crassiceps*. It is of further interest from the point of view of the present comparison to note that this *Cysticercus* is also found in a Rodent, *Arvicola arvalis*. Besides the earlier investigators, Prof. M. Braun\* has studied this form and embodied his results in brief in Bronn's 'Thierreichs'†. The buds from the *Cysticerci* do not apparently contain a prolongation of the bladder-cavity, "sondern durchweg als solide Wucherungen der peripheren Schicht der Wand entstehen." This is an obvious point of similarity with my species, where, of course, the buds cannot be continuous with the cavity of the bladder—that is to say, in both cases the buds are solid outgrowths. Furthermore, before being separated off from the parent *Cysticercus* the attachment of the bud dwindles to a narrow stalk precisely as I have described above. The buds, however, in the case of *Cysticercus longicollis* seem to be limited to the bladder and always to the hinder end of that; whereas in my species this is exactly the region where no buds are formed.

I believe, however, that a nearer approximation to the condition observable in the species which I describe in the present paper is offered by a worm recently described by Ijima‡ with some detail. This is a *Plerocercus* or Plerocercoid found parasitic in a human being in Japan in cysts in the skin. It appears to give off actual buds, which are, however, more or less irregularly arranged and present nothing of the comparative symmetry manifested in the species from *Fiber zibethicus*. The individuals differ in the degree of their budding, some giving off a large series of slender processes. These buds are, as in my species, actual outgrowths of the parent stock and not, for instance, connected with the excretory organs or any other definite part of the body. They occur as much at the head end as elsewhere and there differ from the Tapeworm of *Fiber zibethicus*. There is, however, a resemblance, in that in both cases the more mature buds are not in front of or behind the less mature: there is a complete irregularity in their order of succession.

The similarity between the two cases of budding cannot, however, be carried into any detail, since it is obvious that the two worms are not nearly allied. The Plerocercoid described by

\* See Centralbl. f. Bakt. u. Par. xx. 1896, p. 580; Zool. Anz. 1896, No. 514; *ibid.* 1897, No. 521. These papers are not illustrated.

† Bd. iv. Abth. 1 B., p. 1529.

‡ "On a new Cestode Larva parasitic in Man," Journ. Coll. Sci. Japan, xx. 1905. For a reference to this paper I am indebted to Dr. W. Nicoll.

Ijima is regarded by him—and, as I think, rightly—as a young Bothriocephalid whose larval stages are also known from similar positions in other mammals than man. These larvæ have no bladder, and thus the fact that in the Plerocercoid, as in my worm, the buds are produced from the general body surface loses its principal significance. It is, I think, more important to note that the worm from *Fiber zibethicus* differs from *Cysticercus longicollis*, in that the budding is not upon the bladder end of the worm. It is remarkable, however, that both in my worm and in the Plerocercoid there is no recognisable scolex; but at the same time there is in the supposed young Bothriocephalid no proper segmentation of the body as yet visible. It is thus particularly remarkable that my species is very fully segmented throughout. I think, therefore, that the case of budding which I bring forward in the present paper may be regarded as in some respects a new form of asexual reproduction which is partly paralleled in a few other forms of Tapeworms.

Inasmuch as the propagation of this worm is different in detail from anything that is known, and as the worm itself does not entirely conform with any known species or genus, it is desirable, as I think, for mere convenience sake to give it a name and to define as far as may be the characters of the Cestode. Had the worm proved definitely a Tetracotylean\*, I should have contented myself with referring it temporarily to the genus "*Tænia*," a name which is generally given to forms whose generic affinities are uncertain. As, however, this cannot be done with any certainty, I venture to give a new generic name which is non-committal as to its position in the series, and I term it accordingly

### *Urocystidium gemmiparum*, gen. et sp. n.

*Incompletely mature worm with small bladder and very numerous proglottids. Scolex feebly developed and without hooks. Tubes of water vascular system lateral to each other, the dorsal with thick muscular coat and inside of ventral, the ventrals connected by a transverse vessel which forks and surrounds dorsal vessel; a network present in cortex as well as in medullary region. Longitudinal muscle-layer in cortex of at least two rows of bundles with numerous fibres in each. Buds formed at hinder end of body on both sides, thus forming two rows, of which the bladders are attached to the parent stock; the scolex is not inverted, is without hooks, and rudimentary.*

*Hab.* Musquash (*Fiber zibethicus*), in liver-duct.

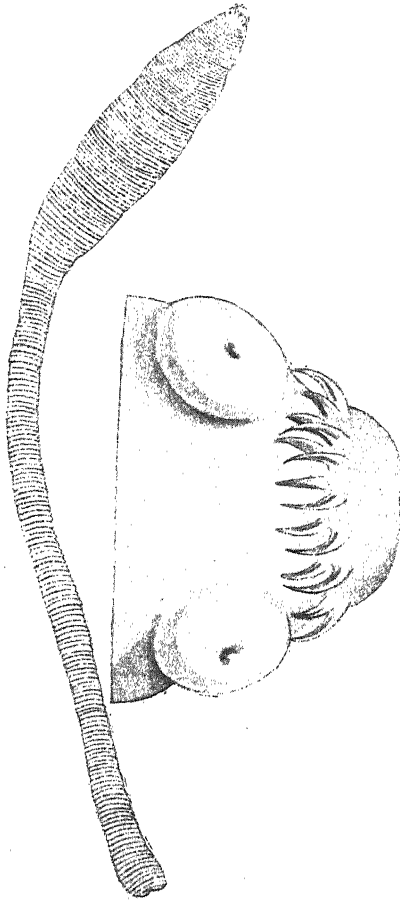
### (2) THE SEXUAL FORM.

As has been already mentioned, the hepatic duct contained besides the "cysticercoid" just described a sexual worm which I

\* I think it necessary to maintain an attitude of reserve with respect to the identity of the asexual and sexual forms.

believe to be the mature form of the same Tapeworm. The size of the two worms was about the same. The sexual form measured 86 mm. in length and the greatest diameter, which occurred not

Text-fig. 118.



The sexual form of *Urocystidium gemmiparum* (?).

The left-hand figure represents the entire worm magnified about twice; the right-hand figure represents the scolex with a double crown of hooks more highly magnified.

far behind the head, was 6 mm. The appearance of the worm (text-fig. 118) was quite similar to that of the immature form. It

was posteriorly of a rather delicate appearance, rather translucent, and the proglottids were very short and enormously wide in proportion. There was no increase in length of the proglottids towards the end of the body, and their proportions were as in the asexual worm. It would hardly, of course, be sufficient to insist upon an identity upon these grounds alone; but, taken in conjunction with other facts which will be dealt with, the similarity in outward appearance is very striking. The "tail" end of the body appeared to be a little excavated, as is common in tapeworms, the penultimate segments slightly embracing the last segment, which was not quite so wide. I can believe that the worm was proliferating at this end.

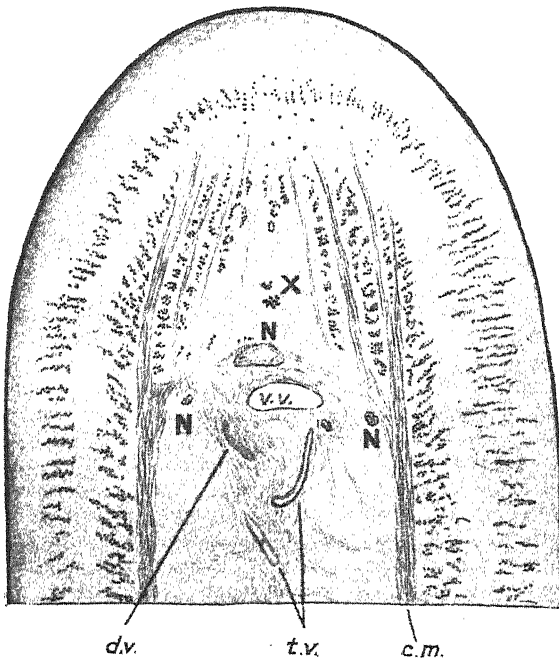
The scolex was not quite so wide as the ensuing strobila, and no appreciable neck separated the two. The scolex is proportionately large, as is indicated in the accompanying text-figure (text-fig. 118), and well armed anteriorly with two rows of hooks alternating in position. The anterior circle of hooks consisted of 16 separate hooks, which were about twice the size of those of the succeeding circle, whose number I did not count, but which were presumably the same, as they were implanted between the larger hooks. The usual four suckers are present; they show no unusual features and are unarmed; their cavity looks forwards.

I have investigated the internal structure by means of transverse and sagittal sections. The cortical layer does not differ greatly from the medullary layer in thickness, and the general appearance of the sections is very like that of sections of the immature worm (see text-fig. 119). The cortex, for example, is identical or nearly so. The same bundles of longitudinal fibres occur and are very much of the same thickness. They are also separated from the medulla by transversely running fibres. I have described and figured in the asexual form the bundle or bundles of rather stouter longitudinal fibres running outside of the nerve-cord on either side and associated with a cavity dubiously related to the excretory system. I find the same arrangement in the sexual worm.

The *excretory system* does not need a very long description, since it agrees in its main peculiarities with that of the supposed asexual form. There are, in fact, the same two lateral vessels on either side lying parallel to each other. They are, moreover, roughly equisized, and the innermost of the two has very thick muscular walls, the fibres being circular in their disposition. I should add that nuclei interspersed among these fibres were very obvious. In addition to these two longitudinal trunks each proglottid possesses a transverse vessel which has the same remarkable mode of union with the ventral excretory tube that I have figured (see text-fig. 115) and described (see p. 830) in the presumed Cysticeroid stage, and which I need not redescribe here as the structure seems to be identical. There is, however, one important difference which the sexual form shows from the Cysticeroid; and that is the absence in the former of the peripheral water vascular

network of the latter. I could find no trace of this in the sexual worm, although it was easy to see in the supposed *Cysticercoid* of the same. It seems to me possible (perhaps necessary) to explain this difference by assuming in the *Cysticercoid* a retention and gradual metamorphosis of the bladder into the strobila, together with its excretory system, which latter ultimately disappears on the assumption of sexual characters. There are, of course, other *Cestodes* in which the bladder is not cast off before the acquiring of sexual characters.

Text-fig. 119.



Part of a transverse section through a proglottid of the sexual worm.

*c.m.* Circular muscles. *d.v.* Dorsal vessel of the water vascular system. *N.* The three laterally running nerve-cords. *t.v.* Transverse water vascular trunk. *v.v.* Ventral trunk. *X.* Large longitudinal muscular fibres referred to in the text as frequently running within a space.

In the neighbourhood of the water vascular trunks delicate muscular fibres are shown running chiefly in a dorso-ventral direction, which may be associated with the dilation and contraction of the water vascular tubes.

The *nerve-cord* shows no trace of the asymmetry which I have described above in the very young worms. There is nothing unusual about the position or structure of the main trunks. There

is, however, on either side of the body and running parallel with the main nerve-cord a second and a third nerve-cord (see text-fig. 119, N) which lie above and below the former and at some distance from it. These accessory nerve-cords appear to be exactly like the main nerve-cord in structure and are situated at the boundary of the medullary and cortical regions, a trifle nearer to the middle of the segment. In sagittal sections the supplementary nerve-cord is very obvious and is seen to be connected with the main trunk by numerous (7 or 8) transverse cords in each segment, which produce a ladder-like appearance. There is an obvious likeness here to *Bertiella*, in which genus the nerve-cord also consists of three separate strands, and to *Dioicocestus*, where the cords are wider apart. They are, however, much closer together in *Bertiella* than in the present worm. I have not observed this arrangement of three nerve-cords in the supposed immature form already described. But it is to be observed that the main cord is there almost as wide as the medulla, thus leaving no room for the accessory cords which may be split off later.

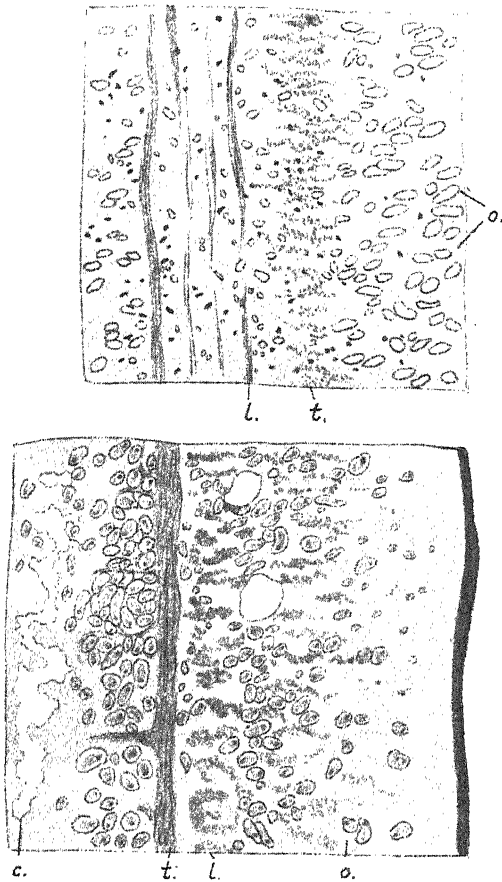
#### § Sexual Organs.

In the middle region of the body and possibly for some way in front (I have not examined sections just in front of the mid-region) the proglottids are full of ripe eggs. I have examined these proglottids in sagittal as well as in transverse sections. The former bring out the important fact that there is apparently no internal boundary-line between the proglottids; for the eggs form continuous masses stretching without intermission from segment to segment. In this region the most careful search failed to show any other genital organs than these exceedingly numerous ripe ova. It is, of course, not uncommon in fully mature segments of tapeworms, such as these in the present form, to find nothing but ova in the medulla; but in those forms there are at least considerable though often altered remains of the genital ducts and terminal apparatus. In the present species there is no vestige of cirrus-sac or vagina and not the least trace that I could discover of an external pore. Nor do I think that it would have been easy to have missed these structures were they present, particularly in a series of sagittal sections. I am, in fact, convinced that they are absent.

The eggs of this tapeworm do not lie in any space or spaces that can be strictly called a uterus. There are, however, spaces which suggest the remains of the uterus. These are not arranged in strict metamerism; but in a certain number of proglottids, and not by any means confined to a single proglottid, are large cavities such as is represented in the accompanying text-figure (text-fig. 120). These cavities are more or less circular and lie in the medullary region of the body. As a matter of fact, they are not at all full of eggs. Indeed, they are often quite empty; but sometimes are eggs to be seen lying within them



Text-fig. 120.



Two sections through portions of proglottids of the sexual worm.

The upper figure is a longitudinal section in the more anterior part of the body, showing the smaller ova lying among and to the inside of the longitudinal muscles (*l.*); these smaller ova lie in what is probably generative tissue, not clearly indicated in the drawing.

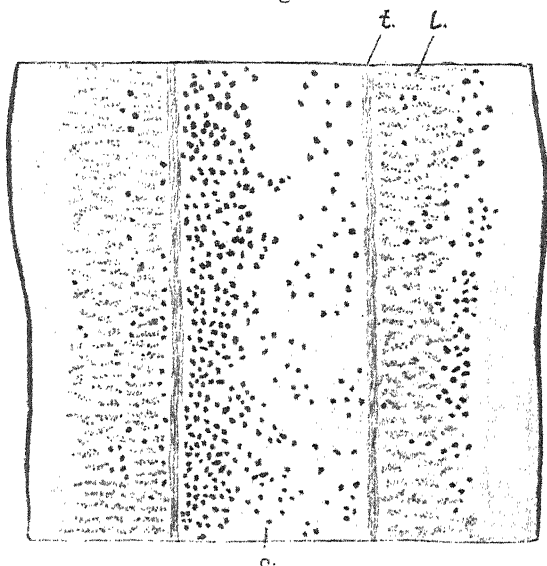
*t.* Transverse muscle fibres. *o.* Mature ova scattered through medulla and also at the opposite side of the figure in the cortex.

The lower figure represents a transverse section through a more posteriorly situated segment.

*c.* A cavity which may possibly represent a uterus; two spaces are shown in the cortex which may or may not belong to the same category. *l.* Longitudinal muscles. *o.* Ripe ova showing a nucleus. *t.* Transverse muscles.

and adherent to their walls. I doubt, therefore, whether these spaces are the remains of the uterus, or whether they are not rather cavities which have arisen in the medullary region perhaps by stretching of the walls of the body and consequent laceration. The eggs, in fact, lie scattered through the parenchyma, sometimes singly and more often in masses of various sizes, as is shown in the figure referred to. The eggs are not limited to the medullary region. It is clearly to be observed that they extend into the cortex (text-figs. 120, 121) a good way

Text-fig. 121.



Part of a transverse section through a proglottid of the sexually mature worm in which the ripe ova (o.) have been very deeply stained and are seen to be scattered through the cortex as well as the medulla.

l. Longitudinal muscles. t. Transverse muscles.

towards the external layer of the body-wall. They stop short, however, some way below it. It is quite certain that whether or no there may be remains of the uterus, some of the eggs lie scattered within the parenchyma. In the cortical parenchyma they are to be seen between the muscle-bundles and closely packed in masses. The appearance is, indeed, not at all unlike that which I have recently described in the tapeworm *Anoplotenia dasyuri*\* in those parts where the cavities of the uterus were not so conspicuous; for in the latter worm there are uterine

\* P. Z. S. 1911, p. 1012, text-fig. 213.

cavities lodging many, perhaps most, of the eggs. The present species is, as it were, a stage beyond that exhibited by *Anoplotenia dasyuri*. As is well known, the imbedding of the eggs in the parenchyma is not a novelty; for *Oochoristica* is a genus which is largely characterised by this very feature, though in this case the eggs are imbedded singly and there are not the heaps of eggs seen in the present species and perhaps in *Anoplotenia*. In *Anoplotenia*, however, the masses of eggs are usually in cavities of the uterus. In both *Oochoristica* and *Anoplotenia*, however, the scattered eggs are limited to the medullary region. But the peculiarity of the species with which I am dealing in the present paper is also known in other forms. Clerc\* has figured eggs in the cortical region in a species of *Dilepis*.

I have some reason to think that the scattered eggs lie in the interstices of the network forming the ground-tissue of the worm; but in any case eggs were also seen lying in larger circular cavities. I believe that these cavities (shown in text-fig. 120) are not the remains of a uterus. They are, as it appears to me, to be directly compared with similar spaces to be seen in mature (but less mature than in the present instance) segments of *Inermicapsifer*, where I have described and figured them†. In this latter case I was able to bring forward some positive evidence to show that the spaces in question were not, and could not be, the isolated series of chambers left by a vanishing uterus. In the worm with which I am dealing in the present communication I am unable to furnish any of those proofs of the nature of the cavities in question. I can merely point out their general similarity to those of *Inermicapsifer*.

Although there were no traces of gonads like those of other tapeworms in this region of the body, I have succeeded in discovering what I regard as undoubtedly the generative tissue. The medulla was packed with ripe ova, which, as already said, stray into the cortical layers lying between the bundles of muscles. But at the line of junction of the cortex and medulla and lying in the latter is a continuous mass of tissue with interspersed nuclei, in and just outside of which eggs in various stages of development are to be seen. This is, as I think, undoubtedly to be regarded as a continuous layer of gonadial tissue. I cannot see any other obvious explanation of it. It is clearly totally unlike the ground-tissue of the tapeworm's body and forms a solid mass with darkly staining nuclei. Its association with developing ova seems to be final in the matter of argument. It is, however, possibly the case that this gonadial tissue is wholly or in part the origin of spermatozoa also; for testes like those of other tapeworms were not found in the present species. I have, however, no evidence of the presence of spermatozoa. The tissue itself is—save where developing ova

\* Rev. Zool. Suisse, t. xi. 1903, pl. xi. figs. 75, 76.

† P. Z. S. 1912, p. 588, text-fig. 77. For the opposite view, see Janicki, Denkschr. Med.-Nat. Ges. Jena, xvi. (1911) p. 381, pl. xiv. figs. 25-27.

are present—naturally indistinctive. The only way of proving its testicular nature is the discovery of spermatozoa. An inability to find these is not of itself conclusive proof of the absence of testicular tissue. But an argument of weight in this direction is to be derived from a study of the ripe eggs. These are rather small as compared with some species and possess a very thick hyaline shell, which is with difficulty penetrated by staining reagents. Thus in many of my sections the eggs seem to be simply oval structureless bodies. In cases, however, where the staining has been more successful the true ovum within the shell becomes obvious. It consists of a single cell with a large nucleus. I say a single cell because there are not vitelline cells enclosed within the shell, anything in the nature of a vitelline body being completely absent. The absence of a vitelline gland is rare among tapeworms, but is known in the genus called on that very account *Avitellina*\*. In no case did I find this ovum in course of division—and I have examined a large number of individual ova in many segments. I infer, therefore, that no spermatozoa are formed in this individual worm and furthermore that there is no entry of spermatozoa from another individual—a fact which is also supported by the absence of a vagina. But it must be remembered that the host may not have contained in the bile-ducts another sperm-producing individual. It may be that fertilisation occurs outside the body. But this is clearly a mere suggestion for the present, though not repugnant to such evidence as there is.

There being no trace of the actual uterus in the middle region of the body, I naturally sought for these bodies elsewhere and made a series of sections from the anterior region of the body. I selected the rather thicker region which immediately follows the head and examined a piece cut from about 10 mm. behind the anterior extremity. Here, as I imagined, the immature uterus might be found or at any rate some trace of its existence. I could, however, find in this part no essential differences from the posterior region of the body which has just been described. The body was in the same way packed in places with the ripe ova, which were present everywhere in a less crowded state; indeed, they seemed to me to occur nearer to the external surface here than posteriorly. I found the eggs only just beneath the external cellular layer of the body-wall. The only conclusion that I can come to is that this worm possesses no uterus, or that it exists for a very transitory period only, and also that very possibly the sexes are separated as in the genus *Dioicocestus*. The specimen described here being a female, this conclusion is obviously based upon negative evidence only and is thus less valuable. It is, however, quite clear to my mind that the generative products develop simultaneously in the proglottids and that

\* See Gough, Quart. Journ. Micr. Sci. vol. lvi. pt. 2, 1911, for an account of this genus.

therefore there is no growth of the worm when it has arrived at sexual maturity. This conclusion, which fits the facts that I am able to set forth, agrees also, it may be pointed out, with the very worm-like cysticercoid stage. There is, so to speak, not much necessity for this immature worm to grow in length before assuming the sexual condition. Far otherwise is it with the typical *Cysticerci*, which are provided with but short strobila as compared with the mature forms of their species. There is at the very least a relation between the two series of facts which is worth noting. It seems to me to be furthermore likely that at no period are there sexual ducts developed—at any rate, no female ducts. This latter circumstance, if true, is not new; for the absence of a female orifice has been asserted in more than one genus of worms belonging to more than one family. *Aporina* among the Anoplocephalidae and many genera among the Acoelidae are instances to the point. It is mainly, indeed, the plain absence of a cirrus-sac which leads me to believe that this worm possesses a dioecious habit so rare in this group.

#### § *General Résumé and Systematic Position.*

It is, I think, obvious from the foregoing account of the sexual form of this worm that it is the representative of a new genus which differs in a good many particulars from any known form. It will be convenient to give a short résumé of the essential characters of this worm, for which the name already given to what I regard as the asexual form may be retained. My reasons for retaining the name of the asexual form are firstly that I have been able to give a more complete account of it than of the presumed sexual form of the same Cestode, and secondly that I cannot fully define the sexual form, concerning whose identity with the asexual form, moreover, some doubt may be considered to remain.

In any case the following are the principal characters of the sexual worm:—Length 86 mm., greatest breadth 6 mm. Head with two rows of hooks 16 in each row, the hooks of the anterior row twice the size of those of the second row. Suckers normal and unarmed. No neck; strobila consisting of numerous proglottids very short and not appreciably longer at posterior end of worm.

Body flat, thicker anteriorly. Cortex about the same diameter as medulla. Two layers of bundles of longitudinal muscular fibres in cortex. Water vascular tubes two on each side lying side by side; dorsal (?) tube with thick muscular walls. A transverse vessel in each proglottid forking round dorsal vessel to join ventral at two points. No water vascular network present. Nervous system consisting of a larger lateral trunk and two smaller trunks, one dorsal and one ventral, connected by many cords in each proglottid to main trunk. The sexes are apparently separate or the worm is protogynous or protandrous throughout.

Female organs consist of a layer of gonadial tissue lying in the medulla at its junction with the cortical layer from which ova are shed into the body, which they permeate even to the outer layers of the cortex. There is no trace of segmentally arranged gonads or of a uterus, nor are the eggs surrounded by any kind of "capsule." There is no vagina or female passage of any kind; the vitelline glands are totally absent. The ripe eggs are surrounded by a thick hyaline shell and none were observed to be dividing and no embryos were discovered in them. Thus it is possible that fertilisation occurs outside of the body.

These characteristics do not entirely fall in with those of any other family of tapeworms. They obviously point to an affinity with the Acoelidae, but do not definitely necessitate the inclusion of this remarkable worm within that family.

### § *Anatomical Summary.*

It may be convenient to extract from the foregoing account of this new tapeworm the more remarkable anatomical facts which I have been able to make out.

- (1) The absence of a marked scolex in the *Cysticercus* of a tapeworm which cannot be placed among the Bothriocephalids and of which therefore it would be expected that the scolex would be very prominent. And correlated with this the necessary assumption that, as in Bothriocephalids, the scolex only develops *pari passu* with the growth in maturity of the worm.
- (2) The enormous size of the strobila as compared with the bladder—a rare condition among the Tetracotylea, but paralleled in *Cysticercus fasciolaris*.
- (3) The very thick layer of muscle surrounding the dorsal vessel of the excretory system and the bifurcation of the transverse vessels round the dorsal vessel to open into the ventral water vascular tube.
- (4) The total absence of generative ducts or (presuming that the species is dioecious) of the female tubes, which is, so far as I am aware, a unique anatomical character.
- (5) The total absence of a uterus or of any trace thereof.
- (6) The diffuse and non-metameric character of the ovaries, which are not sharply differentiated into relatively small bodies of a definite shape.
- (7) The enormous quantity of eggs produced and their existence in quite anterior as well as posterior segments; the eggs are, moreover, found quite as abundantly in the cortical layer as in the medulla. The conditions observable in this part of the generative system are simply an exaggeration of what is to be met with in other genera, where the eggs come to be ultimately scattered through the medullary parenchyma.

50. On Two new Trematode Parasites from the Indian Cobra.  
By WILLIAM NICOLL, M.A., D.Sc., M.D., F.Z.S., Lister  
Institute of Preventive Medicine, London.

[Received May 28, 1912 : Read June 4, 1912.]

(Text-figure 122.)

# INDEX.

	Page
Ethology: Two new Trematode parasites in the gall-bladder and ureters of the Indian Cobra ( <i>Naja tripudians</i> ) .....	851
Geographical Zoology: India; Cobra, two new flukes from the gall-bladder and ureters .....	851
Systematic:	
<i>Xenopharynx</i> (gen. n., Fam. Dicrocoeliidae) <i>solus</i> , sp. n., from gall-bladder of Indian Cobra .....	851
<i>Styphlodora najæ</i> , sp. n., from ureters of Indian Cobra, closely resembles <i>S. horrida</i> Leidy .....	854

In an Indian Cobra (*Naja tripudians*) which died in the Zoological Society's Gardens on 11th October, 1911, a few specimens of two interesting new Trematode parasites were found. Of the first of these a single specimen was found in the gall-bladder; of the second, four somewhat macerated specimens were met with in the ureters. Four different species of Nematode parasites were also present in the same animal, so that altogether it was infected with six different species of parasitic worms.

The first species belongs to the family Dicrocoeliidae and is of particular interest from the fact that members of this family are not commonly found in Reptiles. Hitherto the only typical representative in Reptiles is that described by de Faria (1910). The present species shows most of the characteristic features of the family, but at the same time it exhibits several divergences of such importance as to warrant its being regarded as the type of a new genus. For that genus I propose the name *Xenopharynx*.

*XENOPHARYNX SOLUS*, gen. et sp. n. (Text-fig. 122, B.)

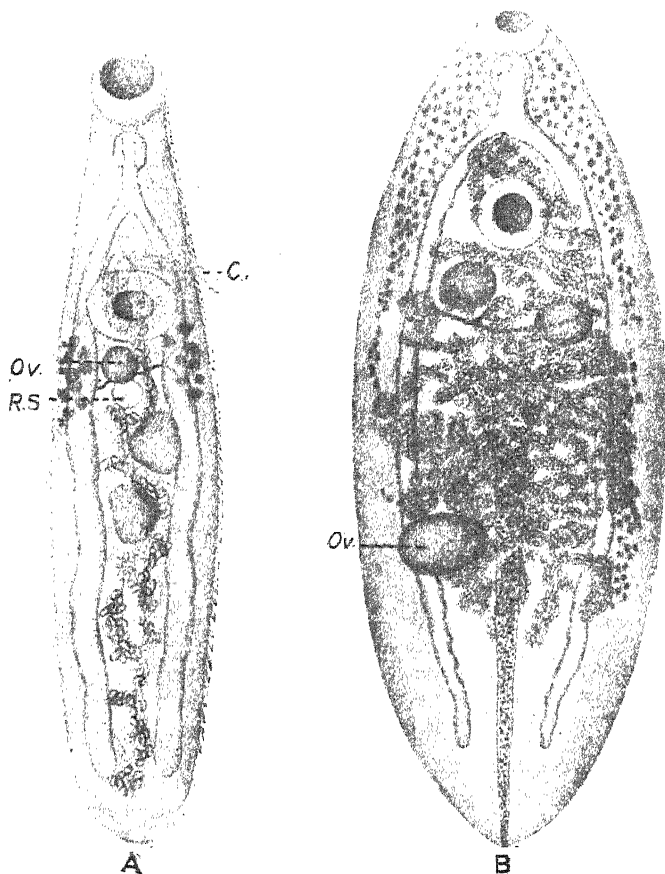
Only a single specimen was found in the gall-bladder. It measures 4.55 mm. in length and 1.68 mm. in greatest breadth, which is about the middle of the body. The outline is almost elliptical and the body is fairly flat. There are no cuticular spines.

The oral sucker has a diameter of .42 mm., but its length is only .30 mm. The ventral sucker is circular, with a diameter of .41 mm. It is situated 1.13 mm. from the anterior end. The neck is therefore almost exactly one-fourth of the body-length.

The pharynx is contiguous with the oral sucker and measures .22 × .24 mm. It possesses the curious shape shown in text-fig. 122, B. At first sight this shape was thought to be the result of

unequal contraction of the pharyngeal walls or perhaps due to the drawing of the œsophagus into the lumen of the pharynx, but neither of these possibilities seemed to accord with experience. The condition appears to be brought about by the thinning of the

Text-fig. 122.



M. Rhodes del.

A. *Styphlodora najæ*, sp. n. Ventral view.  $\times 40$ . C., cirrus;  
Ov., ovary; R.S., receptaculum seminis.

B. *Xenopharynx solus*, gen. et sp. n. Ventral view.  $\times 25$ .  
Ov., ovary.

posterior part of the pharyngeal wall, which anteriorly is of the usual thickness. In section the appearance is somewhat horse-shoe-shaped. It is unfortunate that no second specimen was



available for comparison. Following the pharynx, and about as long as it, is a wide œsophagus, which bifurcates about midway between the pharynx and the ventral sucker. The diverticula are fairly uniform, but become somewhat sinuous towards their termination, which is .45 mm. from the end of the body.

The excretory vesicle is Y-shaped, with a long median stem reaching the middle of the body and two short limbs, the left of which extends as far forward as the left testis. Owing to the fact that sections could not be made, it was impossible to determine whether Odhner's view with regard to the shape of the excretory vesicle in the *Picrocœliidae* holds good in this case. To all appearance, however, the paired limbs are part of the vesicle. Their walls stand out as distinctly, and are about the same thickness, as those of the main stem.

The testes lie not far behind the ventral sucker. They are two transversely oval bodies, separated from each other by a distance equal to their diameter. They are situated obliquely, the right being about half a diameter in advance of the left, and being separated from the ventral sucker by a similar distance. They measure .31 mm. in transverse diameter. The cirrus-pouch is of small size and lies entirely in front of the ventral sucker. It measures .29 × .13 mm., and contains a small convoluted vesicula seminalis, a comparatively long pars prostatica, and a short narrow ductus ejaculatorius. The genital aperture is median, just over the intestinal bifurcation.

The ovary lies a considerable distance behind the testes, about midway between them and the end of the body. It is on the right side overlying the right intestinal diverticulum. Its outline is transversely oval and it is much larger than the testes, measuring .31 × .47 mm. There appears to be no receptaculum seminis, or if present it is obscured by the uterus. The yolk-glands are situated chiefly in the neck, the sides of which they almost completely fill. They extend on each side from the oral sucker to well behind the ventral sucker, but they are more extensive on the left than on the right. On the right they stop at the level of the bifurcation of the excretory vesicle, although there are a couple of small follicles near the ovary. On the left they extend slightly beyond the level of the ovary. In the neck the follicles spread well in towards the mid-line of the body, but behind the ventral sucker they lie entirely to the outer side of the intestinal diverticula. The transverse yolk-ducts cross the body about the level of the testes, and the shell-gland lies just behind the right testis.

The uterus is moderately voluminous and is thrown into irregular narrow convolutions. It does not extend much behind the ovary, but in front it overlaps the intestinal diverticula, and winding between the testes it passes forward on the left side of the ventral sucker and makes a few short turns in front of the sucker before passing into the short vagina. The eggs are small and numerous, measuring .036–.039 × .018–.019 mm.

The new species differs from all other *Dicrocoeliidae* in the distribution of the yolk-glands and in the shape of the pharynx. Another important feature is the distance separating the ovary from the shell-gland complex. From the genus *Dicrocoelium* it is further distinguished by the position of the testes and the ovary and by the extent of the uterus. With *Platynosomum* it is more closely allied, yet the differences between it and this genus are greater than those separating *Dicrocoelium* from *Platynosomum* or *Eurytrema*. It is rather curious that this new species does not show any particularly close relationship to "*Dicrocoelium*" *infidum* de Faria from the snake, *Eunectes marina*. The latter is closely allied to the avian genus *Platynosomum* and should be included in it, unless de Faria's doubtful observation in regard to the excretory vesicle proves to be correct.

*STYPHLODORA NAJÆ*, sp. n. (Text-fig. 122, A.)

Four somewhat macerated specimens of this species were found in the ureters of the Cobra. The species is a typical member of the genus *Styphlodora* and presents a very great resemblance to *S. serrata* Looss and to *S. horrida* Leidy. The features separating it from these two species are so slight that I have some hesitation in regarding it as a distinct species. They are, however, quite as distinctive as those separating the above two species from each other. The difficulty is rather increased by the fact that the present specimens, although mature, are possibly not fully grown.

The length is 2.0-2.4 mm., the greatest breadth .42-.55 mm., which occurs a little behind the ventral sucker. The breadth of the whole postacetabular region is fairly uniform, and there is only a very slight attenuation in the neck. There is a considerable amount of dorso-ventral flattening. In each of the specimens cuticular spines were entirely absent, but it is practically certain that they have fallen off, and it would be unreasonable to suppose that this is an unarmed form. On that account I have had spines depicted in the drawing.

The oral sucker is subterminal and has a diameter of .22-.25 mm. It is rounded and rather shallow. The ventral sucker is slightly transverse and measures .24 x .25 mm. It is only very little larger than the oral sucker, and it is situated at a distance of .67-.84 mm. from the anterior end, *i. e.* about one-third of the body-length. There is a distinct prepharynx followed by a large pharynx measuring about .13 x .14 mm. The oesophagus is about the same length, and the bifurcation takes place midway between the suckers. The intestinal diverticula are fairly straight and of considerable width. They are longer than in the other species of *Styphlodora*, reaching to within .18-.29 mm. of the posterior end. They are very slightly unequal in length.

The main excretory vesicle was entirely invisible, but it was apparent that it gave off numerous lateral branches, which, anastomosing freely, gave the body a honeycomb-like appearance.

The testes lie obliquely behind one another, the left being in

front. They are separated by the uterus, which passes between them, but does not overlap them to any great extent. Their outline is irregular, but they appear to be roughly triangular or trilobate. The anterior testis lies almost exactly midway between the two ends of the body, but its position in relation to the ovary varies somewhat, and it may be slightly nearer than is shown in the figure. The posterior testis is about .27 mm. behind the anterior. They touch the intestinal diverticula or overlap them to a very small extent. Their dimensions are, on an average,  $.21 \times .17$  mm. and  $.22 \times .19$  mm. The cirrus-pouch is of moderate length and uniform width, measuring  $.31 \times .11$  mm. It extends to about the posterior border of the ventral sucker, and contains a convoluted vesicula, a short pars prostatica, and a fairly long ductus ejaculatorius. In each of the specimens the cirrus was exerted and was longer than the pouch itself. The genital aperture is situated in the middle line, almost immediately in front of the ventral sucker.

The small round ovary lies just behind the ventral sucker, a little to the right side, and measures .13 mm. in diameter. Immediately behind it lies a somewhat smaller receptaculum seminis. The yolk-glands lie on each side at the level of the ovary. They are, for the most part, external to the intestinal diverticula, but they also overlap them dorsally. They consist on each side of about a dozen fairly large follicles, which extend from the posterior border of the ventral sucker to the anterior border of the left testis. The transverse yolk-ducts cross the posterior border of the ovary.

The uterus is poorly developed. It passes back between the testes to near the posterior end of the body and returns along much the same path, terminating in a short vagina. It is only slightly convoluted and contains a comparatively small number of eggs. It is confined within the space bounded by the intestinal diverticula, and it does not form any convolutions behind the ends of the intestine, as is the case in the other species of *Styphlodora*. The ova are rather elongated, oval, possessing a large operculum and, in a few cases, a small knob at the anopercular pole. They measure  $.038-.048$  mm.  $\times$   $.019-.024$  mm., the average size being  $.043 \times .021$  mm.

The features which appear to distinguish this form as a definite species are the length of the intestinal diverticula and the restricted extent of the uterus. It is not impossible that both these features may be less marked in a fully-grown specimen. In addition the yolk-glands are slightly less extensive than they are in the other species of the genus. From *S. serrata* it is further distinguished by the relatively larger size of the suckers. Both *S. condita* and *S. horrida* also possess relatively smaller suckers, and in these species the distance between the suckers is considerably less. The only other species of *Styphlodora*, namely *S. similis* Sonsino and *S. bascaniensis* Goldberger, present marked features of difference from the present species.

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51. Statistical Note on the Worm Parasites collected from the Animals dying in the Zoological Gardens, from December 1910 till April 1912. By WILLIAM NICOLL, M.A., D.Sc., M.D., F.Z.S., Lister Institute of Preventive Medicine, London.

[Received May 30, 1912: Read June 4, 1912.]

## INDEX.

	Page
Ethology: Animals dying in the Zoological Society's Gardens, numbers infected with parasitic worms .....	857
Geographical Zoology: Importance of ascertaining distribution of parasitic worms .....	857

At the scientific meeting of the Society held on May 21st last, I referred to the excellent work which is being done by the Prosectorial department in acquiring information concerning the parasites which infect the animals living in the Gardens. This is particularly noteworthy in regard to the worm parasites, about which many valuable facts have been obtained. Following my remarks at the meeting, Dr. Beddard suggested that I might be able to supply some general information regarding the animals which had been sent to me for examination, and acting on this suggestion I venture to offer the following communication.

The scheme, which owes its initiation to the Secretary of the

Society, was put into action in November 1910, and the practical working has been evolved as follows: A general examination of the viscera of all the animals killed or dying in the Gardens is made by the Pathologist, after which certain selected examples are forwarded to me for further examination. The desirability of this latter procedure is shown by the fact that a very large proportion of Entozoa are too small to be detected in the course of an ordinary routine examination; and although the detection of such forms does not involve any very special skill, yet it is a tedious process and one which necessitates some experience. In justification of this extra trouble it may be remarked that the comparatively few animals which have been submitted to this additional examination have yielded almost as large a number of parasitic worms as all the other animals put together. This fact, I venture to believe, is a plea for a still more extended and exhaustive system of examination, dealing with all the animals which die in the Gardens. This, naturally, would involve some additional expenditure, which the Society is probably not at present in a position to incur, but it would certainly yield a very rich return.

In addition to supplying information with regard to the diseases and habits of the animals living in the Gardens, as was the original intention of the scheme, it also provides opportunities of studying the parasitic fauna of the various countries from which the animals come. This is a very important consideration, for it is an unfortunate fact that in most of the large faunistic expeditions which have hitherto been undertaken practically no attempt has been made to deal with the internal parasites. As important exceptions to this may be mentioned the German Expedition to Spitzbergen in 1898, and the Swedish Expedition to Egypt and the White Nile in 1901. By both of these expeditions a large number of parasitic forms has been collected, and the results have been published in a series of very valuable monographs. Dr. Leiper has, at these meetings, on more than one occasion called attention to this regrettable neglect of the parasitic fauna, and has urged on collectors the great service they would render by making even a cursory attempt to collect parasitic worms.

During the past seventeen months a total of 198 animals have been submitted to me for examination, the great majority of which have been birds and reptiles. Of these, 87 were found to be infected with worm parasites of one kind or another, *i.e.*, about 44 per cent. In most cases the infection was single, only one species of parasite occurring; but in an Indian Cobra as many as six different species were found. As is generally the case, Nematode infections were much more numerous than any others, there being 60 cases. Trematodes were found in 28 cases, and Cestodes in 15. The Trematodes belong to about 20 distinct species, a large proportion of which are new, and several of which are new generic types.

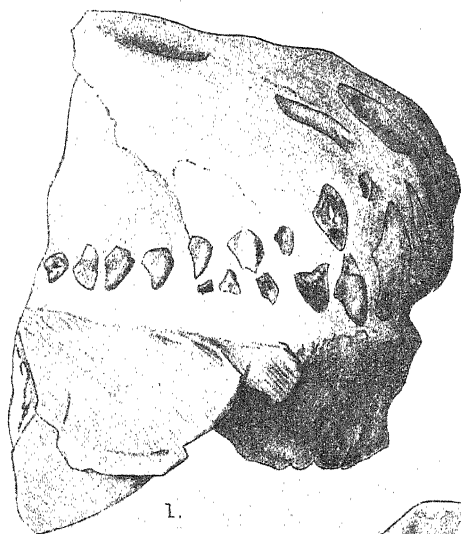
From the reports of Dr. Beddard and Dr. Leiper I gather that during the same period 41 additional cases of infection with tapeworms, and 53 of infection with Nematodes have been observed. To these must be added a very considerable number of infections with larval *Filaria* observed by Mr. Plimmer. These figures, excluding the larval *Filaria*, give a total of about 180, of which the infection with Trematodes, Cestodes, and Nematodes is respectively 28, 56, and 113. This appears to show that Trematode parasites are much rarer than other forms, but that is certainly not the case. It must be remembered that only a comparatively small number of the animals passing through the Prosectorium were adequately searched for Trematodes. The extent to which Trematodes and the smaller intestinal Nematodes escape notice except when thoroughly searched for may be gathered from the following table.

	Trematodes.	Cestodes.	Nematodes.
Total number of cases of infection	28	56	113
Number of cases found only on further examination .....	20	15	60
Percentage .....	71	26	53

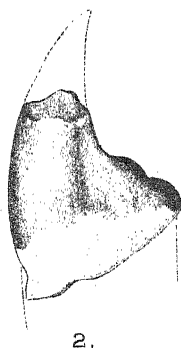
It may be added that the bulk of the Cestoda which were not noted on first examination were small immature forms or fragments of no value. It may therefore be safely affirmed that only a negligible fraction of the mature tapeworms actually escape detection in the Prosectorium. The matter, however, is different with Trematodes; and in view of the fact that only about one-tenth of the total number of animals dying in the Gardens have been submitted to a thorough examination, it must appear that the number of Trematodes actually occurring is considerably greater. Even allowing that they only occur in 5 per cent. of cases, which is taking an extremely low estimate, we ought to have had instead of 28 records a total of well over 100. In the same way the number of small intestinal Nematodes ought to be much increased.

These remarks, however, are not intended as a criticism of the efforts of the prosectorial staff. Parasitic worms are, after all, only a very small part of the work of this department of the Society, and as I have mentioned in the beginning of this communication, considerable praise is due for the results actually obtained. My chief intention is to show that parasitic worms are undoubtedly an important concern and that their importance justifies the attention which is being paid to them. Their claim to notice had until recently been somewhat neglected by the Society, and it seems necessary that someone should offer a plea for their vindication. There can be no doubt that the attention which the Society, thanks to the efforts of Dr. Chalmers Mitchell, is devoting to these forms will do much to benefit Zoology as a whole.

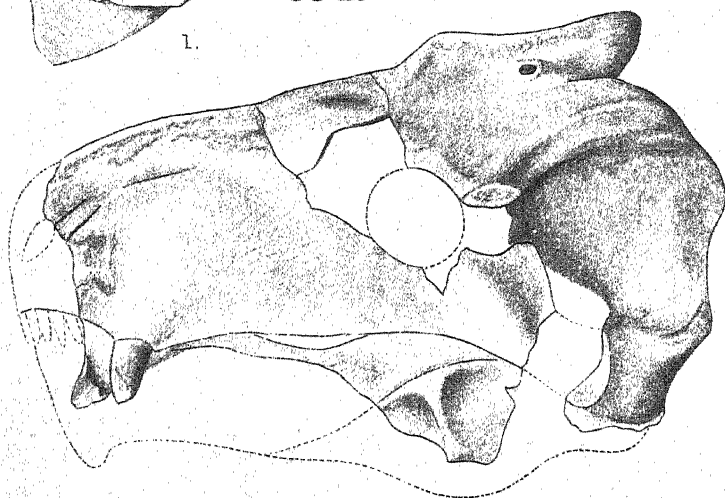




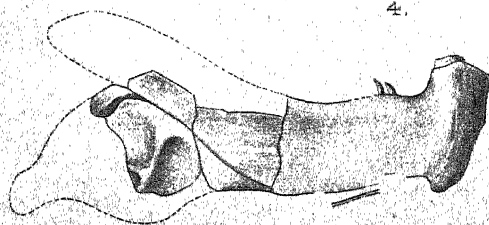
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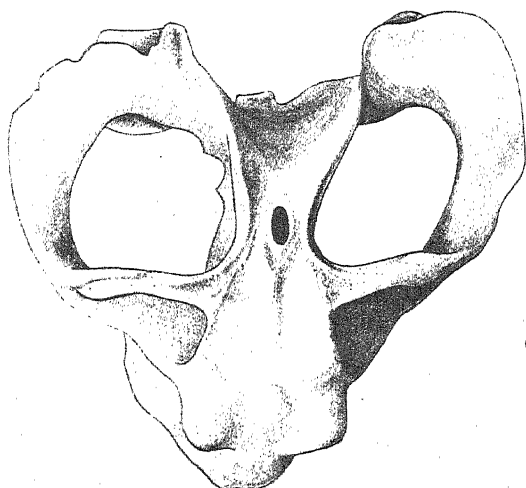
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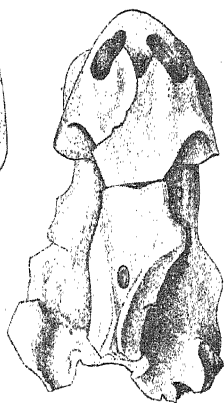
SOUTH AFRICAN FOSSIL REPTILES.



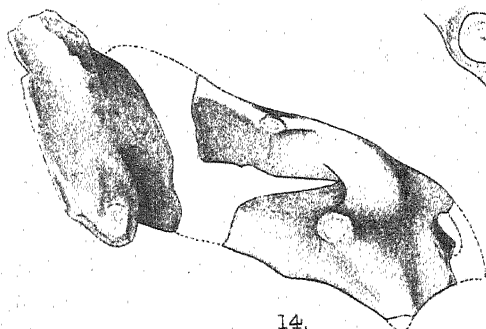




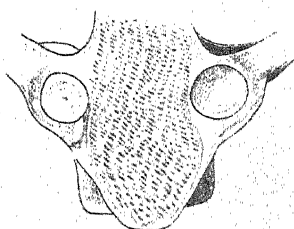
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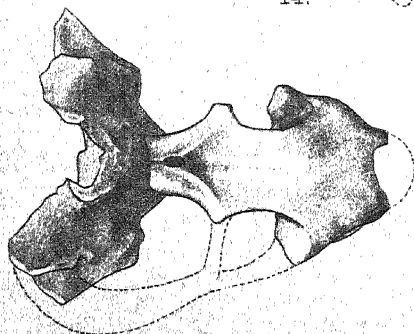
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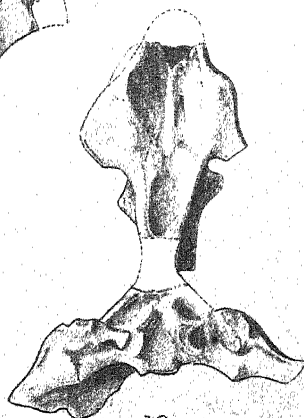
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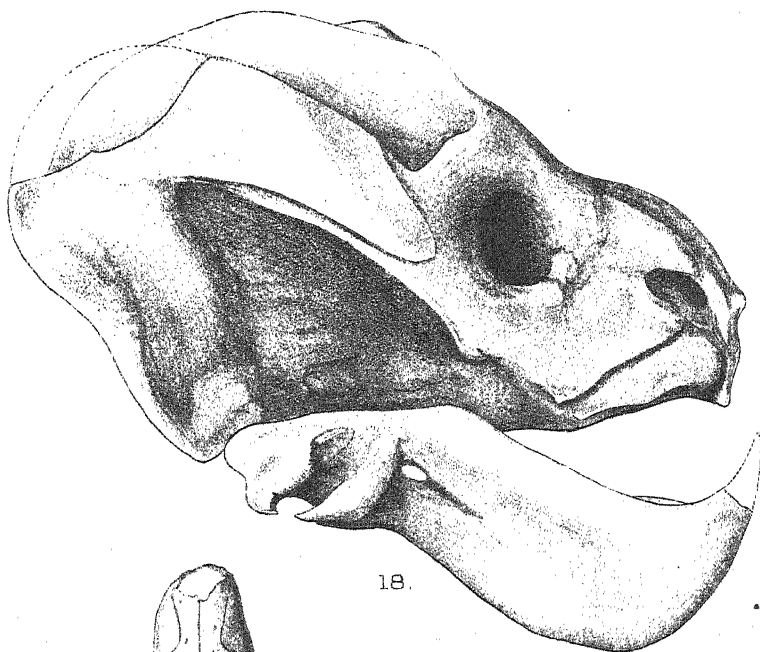
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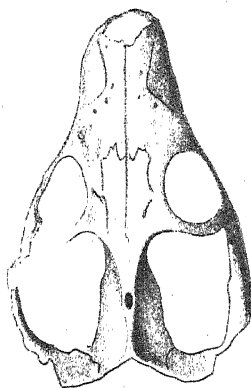
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SOUTH AFRICAN FOSSIL REPTILES.

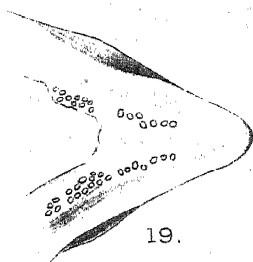




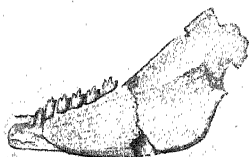
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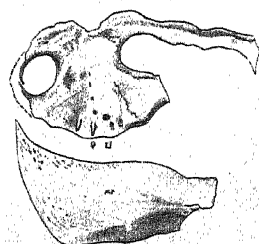
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Huth Lith<sup>y</sup> London.

SOUTH AFRICAN FOSSIL REPTILES.

52. On some new Fossil Reptiles from the Permian and Triassic Beds of South Africa. By R. BROOM, D.Sc., C.M.Z.S.

[Received May 13, 1912: Read June 4, 1912.]

(Plates XC.-XCIII.)\*

INDEX.

<i>Systematic:</i>	Page
Taurops macrodon, gen. et sp. n. ....	859
Galeops whaitsi, gen. et sp. n. ....	860
Scymnognathus whaitsi, gen. et sp. n. ....	861
Elurosaurus striatidens, sp. n. ....	863
Pristerognathus platyrhinus, sp. n. ....	863
Alopecorhinus parvidens, gen. et sp. n. ....	864
Ictidognathus hemburyi, sp. n. ....	865
Endothiodon whaitsi, sp. n. ....	866
E. platyceps, sp. n. ....	867
Prodicynodon beaufortensis, sp. n. ....	867
Dicynodon to include Oudenodon ....	868
Pristerodon to include Opisthoctenodon ....	868
Dicynodon laticeps, sp. n. ....	868
D. psittacops, sp. n. ....	869
D. lutriceps, sp. n. ....	870
Emydops minor, gen. et sp. n. ....	871
Ictidopsis elegans, gen. et sp. n. ....	872
Nyctosaurus browni, sp. n. ....	874
Endothiodon subdivided: see Addendum ....	875
Emydochampsia, gen. n. ....	875

The following series of new reptiles forms an important addition to our knowledge of the Karroo faunas. The majority have been found by the Rev. J. H. Whaits, of Beaufort West. Of the others one was found by Mr. Alfred Brown, of Aliwal North, one by Mr. H. J. Hembury, and a few by myself.

Suborder DINOCEPHALIA.

TAUROPS MACRODON, gen. et sp. n. (Pl. XC. fig. 1.)

The snout of this large Dinocephalian was obtained at Bosmanshoek at the foot of the Komsberg. Though so little has been obtained we have enough to give the distinguishing characters of this new type. In size it almost equals *Tapinocephalus atherstonei*, but the snout though narrower is considerably deeper, and it differs in the great degree of development of the teeth, especially of the incisors. Where the snout is broken across, about the transverse plane of the back of the anterior nares, the width is 190 mm. and the height about 100 mm. The anterior nares are unusually small and situated about 90 mm. from the front of the snout. The distance between the two nostrils is about 45 mm. The condition of the bone renders it almost impossible to make out the sutures, the only one that is distinct being that between the two premaxillaries.

\* For explanation of the Plates see p. 875.

The teeth are for the most part badly preserved, but as they are broken off at different levels and as a large number of replacing teeth are present, the structure can be made out without much difficulty. There are 14 teeth preserved, of which the first five are large and long. From the 6th backwards the teeth steadily decrease in size and the crowns become quite short. Possibly there are two or three teeth lost behind the 14th, but it seems improbable that there are many. The anterior teeth are of the usual Dinocephalian type. They are, except where the root is being absorbed by a replacing tooth, of great length, the whole root and crown being about 90 mm. The anterior cusp is long and narrow, and on section is semicircular. At its base it measures about 9 mm. across and gradually narrows towards the point. None of the anterior upper teeth shows the whole anterior cusp, but it probably measures about 20 mm. in length if not more. The posterior basal cusp is about 15 mm. in width and has a slightly concave surface. The posterior teeth have short cusps. The 12th tooth has a crown only 12 mm. in height.

The teeth in the lower jaw are apparently closely similar in type to those in the upper. Most of the functional teeth are badly weathered away, but the weathering shows that at the base of each is a well-developed replacing tooth similar in type to the functional one. It seems probable that the long anterior cusps of the front teeth interdigitated and that the grinding took place by the meeting of broad posterior cusps. The edges of the long anterior cusps would thus form an admirable cutting apparatus, and the internal cusps would take the part of molars. In the Dinocephalians almost the whole dental apparatus is placed in the front of the snout, and the absence of grinding molars such as are seen in the contemporaneous or slightly earlier American herbivores, e. g. *Diadectes*, is explained by the crushing or grinding function having been taken up by the peculiarly specialised incisors.

#### Suborder DROMASAURIA.

##### GALEOPS WHAITSI, gen. et sp. n. (Pl. XCI. fig. 6.)

This new genus is founded on the anterior half of the skeleton of a Dromasaurian. The skull is crushed but fairly well preserved, and the shoulder-girdle and front limb are in good condition, while remains of about 18 vertebræ are seen. Unfortunately the matrix is very hard and little can be done in the way of development. The specimen was found by Mr. Whaits on the farm La-de-da, about 20 miles to the west of Beaufort West, and probably belongs to the upper part of the *Pareiasaurus*-Zone.

The skull is in many respects very remarkable. The orbit is exceedingly large and the temporal fossa deep and very narrow, and the squamosal has a long descending process which brings the quadrate below the back of the orbit. The face is very short, and there appear to be no teeth in either upper or lower jaw.

The bones of the skull are not in good condition for showing

sutures. The snout is missing in front of the nostril, but from the shape of the lower jaw its length can be fairly well assumed. The nostril is large and the distance between it and the orbit very short. It is probable that the septomaxillary meets the lachrymal. The suborbital and postorbital arches are slender. The frontal and parietal regions are both fairly wide and there is a large oval parietal foramen. The squamosal is somewhat like that of the *Dinocephalia*, but is slender and the descending process very long. There appears to be a distinct quadrato-jugal. The palate, so far as preserved, agrees with that of the *Therocephalia*. There is a pair of long slender prevomers, and the palatines and back of the pterygoids are not unlike those of *Scylacosaurus*, but whether in other respects the palate is *Therocephalian* or *Dinocephalian* the evidence does not show. Certainly the palate is not the least like that of the *Anomodont*. The lower jaw is short and toothless. It agrees fairly closely with that of the *Anomodont*, but there is a rudimentary coronoid process.

The shoulder-girdle has a large distinct precoracoid and coracoid loosely articulated to each other. The scapula is somewhat like that of the *Dinocephalia* and also a little like that of the *Therocephalian* *Ictidosuchus*, but unlike that of the *Anomodont*. The limb bones are long and slender.

*Galeops* is an entirely new type of *Dromasaurian* and represents a new family, the *Galeopidae*, characterised by the absence of teeth and the presence of a small coronoid process. The other family, which may be called the *Galechiridae*, includes *Galechirus* and *Galepus*, both with teeth and without a coronoid process.

#### Suborder THEROCEPHALIA.

*SCYMNOGNATHUS* WHAITSI, gen. et sp. n. (Pl. XC. figs. 4, 5.)

This interesting type was found by Mr. Waits near Beaufort West. Within quite a small area remains of four or five animals were obtained. Unfortunately, most of the bones are extremely weathered, and so infiltrated with lime as to be practically limestone nodules so hard that any development is almost impossible. Two skulls are sufficiently well preserved to show the general characters of the genus, though it is impossible to be sure of most of the sutures.

The new type is a very near ally of *Gorgonops torvus* Owen, and it is only after considerable deliberation that I have decided to place it in a new genus. With perfect certainty it can be placed in the Family *Gorgonopidae*. When Owen first described *Gorgonops* in 1876 he unfortunately came to the conclusion that the temporal fossa was roofed over as in *Labyrinthodonts* or *Pareiasaurus*, and this mistake was also made by Lydekker in 1890, and by Seeley in 1895. On examining the type and, at that time, only known specimen when in London three years ago, I discovered that the temporal fossa is not roofed over, though the parietal region is broad, and noted the observation in a paper

published in 1910\*. Within the last few months Mr. Whaits has fortunately discovered a good skull of *Gorgonops* which shows that it has quite a large temporal opening, very similar to that in the present genus.

In general appearance *Scymnognathus* differs from the more typical Therocephalians mainly in having the intertemporal region about as wide as the interorbital. The snout is long, the orbits small, the temporal region fairly wide, and the squamosals more powerfully developed than in most Therocephalians.

The total length of the skull is, in the type, 305 mm. In a second but much crushed specimen the length is probably about 325 mm. From the front of the snout to the front of the orbit the measurement in the type is 165 mm., and the length of the orbit about 40 mm. The interorbital width in the type is 70 mm.: in another very imperfect specimen it measures 78 mm., and in a third about 76 mm. The narrowest part of the parietal region measures in one of the larger specimens 78 mm.

The parietal foramen is situated well back and is 6 mm. in diameter.

Though the limits of many of the bones cannot clearly be made out, much of the cranial structure can be seen. The bones of the snout seem to agree with those of the better known Therocephalians, though the septomaxillary is relatively larger. The jugal is unusually well developed and the postorbital is very large. The postfrontal also seems to be much larger than in any other type hitherto examined. The squamosal is more massive than in most Therocephalians, and the quadrate is relatively small and largely hidden by the squamosal. The occipital condyle is single.

The lower jaw is fairly similar to that previously described and figured in *Lycosuchus* and *Aloposaurus*. The front of the dentary is very deep and has a well-marked mental process. Posteriorly the dentary has a short coronoid process and for a considerable distance lies above the angular. The surangular is much smaller than in other known Therocephalians.

There are five upper incisors, one large canine and three or four molars. The incisors are long pointed teeth, oval in section, and apparently without serrations. The space occupied by the five incisors in three specimens is 37 mm., 39 mm., and 40 mm. The space between the last incisor and the canine in four specimens is 18 mm., 22 mm., 25 mm., and 26 mm. The length of the canine in seven specimens is 16 mm., 18 mm., 20 mm., 20 mm., 20 mm., 20 mm., and 21 mm. Behind the canine is a diastema varying from 7 mm. to 16 mm., followed by either three or four molars. The number of molars apparently depends on age. When three molars are present the distance occupied by them is 20 or 21 mm.: when four are present they occupy 25 mm. to 29 mm.

The dental formula is, i.  $\frac{5}{4}$ , c.  $\frac{1}{1}$  m.  $\frac{3 \text{ or } 4}{3 \text{ or } 4}$ .

\* "Observations on some specimens of South African Fossil Reptiles preserved in the British Museum." Tr. Roy. Soc. S. Afr. vol. ii. pt. 1, 1910, p. 20.



*Scymnognathus* may prove to be related to *Scymnosaurus*. The dental formulæ are practically the same in the two genera, but *Scymnosaurus* seems to be a higher type of Therocephalian, and the shape of the snout and lower jaw differs sufficiently markedly to justify one in keeping the genera distinct.

*ÆLUROSAURUS STRIATIDENS*, sp. n. (Pl. XCI. fig. 7.)

The imperfect snout which forms the type of this new species was discovered by me at Kuilspoort, near Beaufort West, at a horizon which is probably 500 feet above the town.

It is a smaller species than *Æ. felinus*, and in addition differs from this and the other known species in the relatively small size of the teeth, in the feeble development of the serrations, and in the incisors and canine having feeble vertical ridges on the enamel.

So far as preserved there is a pretty close agreement in the structure of the bones of the snout with those of previously described species. The septomaxillary is larger than usual. The mandible has a broad angular chin.

The incisors are small, rounded, pointed teeth, placed so near each other as to be almost touching. Those whose crowns are preserved (3rd, 4th, 5th) have the enamel folded into about half a dozen vertical corrugations. The 5th tooth has fine serrations on its posterior edge. The space occupied by the five incisors is 16 mm. The diastema between the 5th incisor and the canine is 7 mm.

The canine is long and slender. The base measures antero-posteriorly 7 mm. and the height of the crown as preserved is 14 mm. It originally probably measured about 20 mm. The molars are small with only faint indications of posterior serrations. Two are well preserved and there are remains of the other two. Probably 5 is the complete number, which would make the dental formula agree with the other species of *Ælurosaurus*. The four preserved molars measure 10 mm., and the front one is only 9 mm. behind the canine.

*PRISTEROGNATHUS PLATYRHINUS*, sp. n. (Pl. XCI. fig. 8.)

The specimen which I take as the type of this new species is an imperfect snout found by Mr. Whatits at Grootfontein, about 12 miles to the west of Beaufort West, and probably from the upper part of the *Pareiasaurus*-Zone. The specimen consists of the front half of the skull. It is broken into three pieces and the upper nasal region is missing. The matrix is extremely hard and difficult to clear off, but most of the characters can be satisfactorily made out.

In the large majority of Therocephalians the snout is deeper than broad. In this specimen the snout is broad and flat, and the lower jaw comparatively straight and with very little of the usual upcurving in the canine and incisor region. The widest part of the snout is immediately above the canine, where it measures 55 mm., and on the same plane the height of the snout is 40 mm.

There is very little crushing. Nearer the front of the nose the height is only about 25 mm. and the width 45 mm. The maxillary bone is rather deeply pitted. The palate is broad and flat behind and in front slopes upwards to the opening of the internal nares. The prevomers are narrow slender bones which in section are seen to have thin vertical plates. The palatines are apparently as in *Scylacosaurus*, but appear to approach each other more closely in the middle line. The pterygoids have each a very thin vertical plate which is closely placed against its neighbour.

There are apparently 6 incisors, though only evidence of the last five are preserved. The anterior ones are fairly round on section, but the last three are more flattened and have a posterior edge which is not improbably serrated. The teeth decrease in size as we pass backwards, the 6th being only about half the size of the 4th. The last four teeth occupy a space of 20.5 mm. and the whole six probably 30 mm. The diastema between the 6th incisor and the canine is 9 mm. The canine at its base measures 10 mm. by 7 mm. Behind the canine is a diastema of 7 mm. followed by 8 pointed molars. Each of the anterior molars has an antero-posterior diameter of nearly 3 mm., and the whole series occupies a space of 29 mm.

The dentition of the lower jaw is mainly concealed in front. Probably there are 3 incisors and 1 canine. The molars are well shown on the right side and are 8 in number, and occupy a space of 32 mm. There is no evidence of any serrations, and were they present the specimen would be expected to show some of them.

The dental formula is probably  $i. \frac{6}{3}, c. \frac{1}{1}, m. \frac{8}{8}$ .

There is some doubt whether this specimen belongs to the same genus as *Pristerognathus polyodon* Seeley. The type is only the front of a snout, and the number of molars is unknown, and only a figure of the underside is given by Seeley. However, the two specimens are probably from near the same horizon, and the arrangement of the teeth, so far as known, is sufficiently close to render it advisable to place this new species provisionally in Seeley's genus *Pristerognathus*.

#### ALOPECORHINUS PARVIDENS, gen. et sp. n. (Pl. XCI. fig. 9.)

This new genus is founded on an imperfect snout discovered by Mr. Whaits at Beaufort West. It consists of the greater part of the left maxillary and dentary and much of the right maxillary and dentary.

It resembles *Pristerognathus platyrhinus* in the broad short nose and approximates in dental formula, but differs in having a much more slender jaw and in the relatively smaller size of the teeth, especially the molars, and in having a much shorter precanine portion of the snout.

The anterior upper incisors are lost but there is evidence of the last three. The whole series probably measured 19 mm. The

diastema between the last incisor and the canine is only 2 mm. The canine measures at its base 6 mm. by 5 mm. The molars are at least 7 in number, and are small, pointed but apparently unserrated teeth. The seven occupy 17.5 mm. Between the canine and the first preserved molar is a diastema of 9 mm.

The lower incisors are preserved in section and are 4 in number, the 4th being inside the line of the others. The canine is far forward and small and rounded, the section measuring 3.5 mm. in diameter.

The dental formula is probably  $i. \frac{6}{4}, c. \frac{1}{1}, m. \frac{7(?8)}{p}$ .

*ICTIDOGNATHUS HEMBURYI*, sp. n. (Pl. XCI. figs. 10, 11.)

This new species is founded on four imperfect snouts found by Mr. H. J. Hembury at Beaufort West. There are minor differences between the snouts probably due to crushing, to age, and possibly to sex, but I believe they all belong to one species. To avoid any possibility of confusion I shall take the skull (fig. 10) as the type. It is the best preserved specimen but does not show the molars satisfactorily.

As in *Alopecorhinus* the snout is broader than deep. This is probably also the case in *Ictidognathus parvidens*, but the only known specimen of this species is considerably crushed. From the front of the snout to the front of the orbit the measurement is 42 mm. The antero-posterior diameter of the orbit is 18 mm. The interorbital region is 19 mm. across. The measurement across the snout at the canine region is about 27 mm.

The premaxillary is a very small bone forming the anterior and lower margins of the nostril. It carries six small pointed, rounded, smooth incisors. I fail to detect serrations on any of them. The six incisors occupy a space of 10 mm.

The septomaxillary is unusually large and forms as large a part of the facial surfaces as does the premaxillary. There is the same foramen between it and the maxillary seen in typical Therocephalians, but it is relatively smaller than in other forms.

The nasal bone is well developed and is interesting from the fact that it is only very little broader behind than in front.

The maxillary is typically developed. As in so many Therocephalians, the centre part of the bone is markedly pitted as if for the accommodation of glands or sense organs. In the same region there are numerous foramina passing into the bone, and some of these foramina lead back into a canal in the bone. As there is no large foramen in the maxillary bone which might be regarded as the foramen for the maxillary branch of the Vth nerve, I think it probable that this nerve subdivides in the maxillary bone and comes to the surface by a number of small foramina, and that the pits were for sense organs which were supplied by this nerve. The tactile vibrissæ of mammals, or the remarkable sense organs of the beak of *Ornithorhynchus* may be the modified homologues of these supposed ancestral organs.

There are two canines—a very small anterior and a fairly large long slender posterior one. The small canine has a diameter of .5 mm.; the large canine measures 3.5 mm. by 4 mm. The two are a little more than 2 mm. apart. The exact number of molars is a little doubtful but appears to be 8, and they occupy 16 mm. in one of the specimens. The molars appear to be all short, smooth, pointed teeth without serrations.

In the lower jaw there are four incisors, a large canine, and eight molars. The dental formula would thus be  $i. \frac{6}{4}, c. \frac{2}{1}, m. \frac{8}{8}$ . In *Ictidognathus parvidens* there are certainly nine upper molars and possibly ten, but as this species is certainly allied to *I. parvidens* it seems better to keep both in the same genus.

#### Suborder ANOMODONTIA.

##### \* ENDOTHIODON WHAITSI, sp. n. (Pl. XCIII. fig. 18.)

This new species is only known by the skull, a few vertebrae and ribs, and a couple of limb-bones. Fortunately the skull is in beautiful condition. The specimen was discovered by the Rev. J. H. Waits at Beaufort West. It is a near ally to *Endothiodon uniseries* Owen, and has the molars in a single row, but it differs from *E. uniseries* in a considerable number of points besides in being nearly twice as large. In *Endothiodon uniseries* the greatest length of the skull is 360 mm.; in *Endothiodon whaitsi* the skull measures in length 570 mm. With the exception of *Oudenodon magnus* it is the largest known Anomodont. As I hope shortly to publish a full account of the genus *Endothiodon*, I shall here merely give a preliminary description of this interesting species.

The skull is narrow and deep. The greatest width across the squamosals is probably about 360 mm., while the interorbital region is only 140 mm. and the greatest width of the palate 150 mm. There is a slight degree of crushing, but not such as to make these measurements far wrong. The notch in the premaxilla for the point of the lower jaw is very deep and narrow. The nostrils are large, measuring 65 mm. by 45 mm. The nasals do not overhang them as in *E. uniseries*, the whole width of the nasals being only 85 mm. The orbit is situated 180 mm. behind the front of the snout and measures from 60 to 65 mm. in diameter.

The parietal crest forms a huge arch over the top of the head about 300 mm. in length. It is very narrow for its depth, and is mainly formed by the postorbitals and the squamosals, the parietals being relatively small. Near the union of the anterior and middle third the two postorbitals are pushed apart by an enormous development of the preparietal. This forms a prominent boss 90 mm. in length and 50 mm. in width, and rising 20 mm. above the edge of the postorbitals. In it is situated the

\* See also Addendum, p. 875.

parietal foramen, which is only about 10 mm. in diameter. This is the more remarkable in that in *E. uniseries* the foramen measures nearly 20 mm. in diameter.

The zygomatic arch is very massive. The malar process of the jugal is less marked than in the smaller species. The squamosal extends forwards to below the postorbital arch. Anteriorly the zygomatic arch measures 65 mm. in depth and posteriorly 80 mm.

The lower jaw is very powerful and measures 400 mm. in greatest length.

\* *ENDOTHIODON PLATYCEPS*, sp. n. (Pl. XCIII. fig. 19.)

This new species was also discovered by Mr. Whaits, near Beaufort West. It is founded on a fairly complete but slightly crushed and probably barely mature skull. The lower jaw is complete, and the only important part missing from the skull is the whole of the nasal region and the anterior part of the frontal.

The greatest length of the skull is 275 mm., and the greatest width about 215 mm.

The frontal region is flat, and the parietal crest instead of rising up from this is continued straight back. There does not appear to be a distinct postfrontal bone. The preparietal is large and passes forwards for 35 mm. in front of the pineal foramen. The foramen is 14 mm. wide and 8 mm. in antero-posterior diameter. Behind it is a large boss formed by the preparietal. There is nothing particularly noteworthy about the squamosals, jugals, or occiput.

The dentition is better seen in the lower than in the upper jaw. It is made up of a series of 7 teeth in a fairly regular row. Behind this the same row has 9 more teeth, but median to these there appear others, so that the front half of the dentition is an irregular single row, the back half an irregular double row. Parts of the crowns of two teeth are preserved and there appear to be no serrations on them. If this prove to be the case, this species will require to be placed in a new genus, as *Endothiodon bathystoma* has the teeth markedly serrated in front and behind.

The lower jaw is pointed in front, but at the lower part of the symphysis it is very broad. The back part of the dentary is unusually slender. *Endothiodon platyceps* differs from *E. uniseries* and *E. whaitsi* in the double row of teeth behind and also in the flat broad head; while from *E. bathystoma* it differs even more markedly. The teeth are smaller than in the other species.

*PRODICYNODON BEAUFORTENSIS*, sp. n. (Pl. XCIII. fig. 21.)

This small species is founded on an imperfect skull obtained by me at Kuilspoort at about the same horizon at which *Taognathus megalodon* was found. The specimen consists of the crushed ant-orbital portion of a small skull with the front two-thirds of the

\* See also Addendum, p. 875.

lower jaw in position. At first sight the skull might readily be taken for that of a small *Oudenodon*, but there are two marked differences. There are a number of small maxillary teeth, and the lower jaw ends in front in a pointed beak which fits into a deep depression in the premaxillary exactly as in *Endothiodon*. There is no tusk.

The nostril is 8 mm. in length by 7 mm. in depth. The orbit is 12 mm. behind the nostril. The inter-orbital width is probably 14 mm. Close to the outer edge of the maxillary bone are at least two small smooth pointed molars, and other molars are arranged in a row further in.

The lower jaw is almost typically *Endothiodont*.

The only form nearly related to the present one is that described by me eight years ago as *Prodicynodon pearstonensis*. The two agree in the arrangement and structure of the molars, but differ markedly in the proportions of the head. *P. pearstonensis* has a much broader snout and an enormous premaxillary. It also has the orbit much further back. As neither type is in good condition it is impossible to affirm with certainty that the two species belong to the same genus, but at present it will be convenient to keep them together.

When *Prodicynodon* was first described, and until recently, the presence or absence of a tusk was believed to be a generic distinction. *Dicynodon* and *Oudenodon* were believed to be distinct genera. For the last five years the evidence has been steadily accumulating in favour of the tusk being merely a sexual character, and now the evidence seems to be conclusive. Mr. Whaits has collected a large number of the common little Beaufort West *Endothiodont* *Dielurodon whaitsi*, and tusked and tuskless specimens seem to be about equally common, while there are no other characters to separate the specimens. Mr. D. M. S. Watson has succeeded in obtaining two specimens of *Oudenodon bolorhinus* recently described by me from Kuilspoort, at the same locality as afforded the type, but one specimen is tusked and the other tuskless.

This conclusion will necessitate the giving up of the genera *Oudenodon* and *Opisthoctenodon* and placing the species of these old genera under *Dicynodon* and *Priesterodon*. Fortunately very little confusion will result, as I have for years assumed the possibility of the tusk being merely sexual.

*DICYNODON LATICEPS*, sp. n. (Pl. XCII. figs. 12, 13.)

This new species of *Dicynodon* is founded on a beautiful skull obtained by Mr. J. H. Whaits on the Nieuwveld. With the exception of the lower jaw being missing and the tips of the maxillaries with most of the tusks being broken off, the skull may be regarded as perfect. It belongs to the very unusual broad-headed variety of which only a few specimens are known. When viewed from above the resemblance is so close to *Dicynodon tigriceps* Owen as to suggest that it might be a young specimen,

but the palatal view shows that the tusk is differently placed and relatively very much larger.

The greatest length of the skull measured obliquely from the snout to the back of the squamosal is 270 mm., and the greatest width across the squamosal is also 270 mm.

The snout is very short and the nostrils completely roofed over by the projecting nasals. The breadth across the nasals is 83 mm. The premaxillary is broad and shallow. The maxilla is short and also shallow. The tusk is large and situated right beneath the orbit, and directed downwards. In diameter it measures 25 mm. by 28 mm. at its base. The frontal region is broad and flat, the narrowest part between the orbits being 63 mm. If there is a distinct postfrontal it is very small. The parietal foramen is large, measuring 15 mm. by 10 mm. The preparietal lies mainly in front of it. The parietals are unusually large, and the posterior branch of the postorbitals more slender than in most species. The postorbital forms the front half of the long slender post-orbital arch. The squamosal extends forwards below the post-orbital arch and has a large articulation with the maxilla. The pterygoids where they meet are broad and, except for the median ridge, flat. Considering the great width of the skull the quadrates are not far apart.

The general structure of the skull will be better understood from the illustrations given.

*DICYNODON PSITTACOPS*, sp. n. (Pl. XCII. fig. 17.)

In working at the troublesome genus *Dicynodon* we have constantly been in doubt as to whether the small *Dicynodon* specimens are distinct species or only young animals. Frequently they agree sufficiently in general shape and structure as to suggest the probability of their being young specimens of *Dicynodon leoniceps* or some other large species. But this is certainly not always the case. Many specimens of *Dicynodon jouberti* are known from the *Pareiasaurus* horizon and all small, while no large *Dicynodon* is known to occur in the same zone. At Beaufort West a considerable number of specimens of a small *Dicynodon* also occurs, but there is no evidence of any large *Dicynodon* having lived at the period. The large Anomodonts are the Endothiodons. There is thus satisfactory evidence that the common *Dicynodon* of the Beaufort West commonage is an adult animal, and apparently a new species. The best specimens are a good skull with much of the skeleton and a fairly good skull with nearly the complete skeleton. I take the latter as the type. Both specimens were obtained by Mr. J. H. Whaits.

The greatest length of the type skull is 102 mm., and of the second specimen 112 mm. The width of the type across the squamosals is about 66 mm. Across the maxilla the maximum width is 42 mm. The interorbital width is 20 mm., and the intertemporal 18 mm.

The following are the most noteworthy characteristics of the

species. The nasals are so narrow that the nostrils look almost directly upwards. The upper part of the nasals is thickened, and the prefrontal region of the orbital margin is also elevated. The frontal region is broad and flat. The parietal foramen is situated in an elevated preparietal. The postorbitals approach each other behind the foramen and nearly touch, forming a parietal ridge. The tusk is small and directed forwards and downwards. The lower jaw has the front portion unusually broad and deep. The foramen behind the dentary is very small.

The whole skeleton from the snout to the end of the tail probably measures 500 mm.; the humerus measures 50 mm. and the femur 58 mm.

*DICYNODON LUTRICEPS*, sp. n. (Pl. XCII. figs. 14-16.)

The type of this new species is an imperfect skull found by me at Kuilspoort, Beaufort West district. The skull has lost the tip of the beak, the postorbital and zygomatic arches, and there is about 20 mm. missing from the postpterygoid and from the parietal region so that the contact between the occipital and anterior portions of the skull is lost, but otherwise the skull is complete.

The most noteworthy characters of the type are the relative shortness of the beak, the broad concave frontal region, and the broad flattened intertemporal region, the upper surface of which is almost entirely formed by the postorbitals. In a maxillary from the same locality, and believed to be of the same species, the tusk is feeble and directed downwards and slightly forwards.

The greatest length of the skull from the snout to the back of the squamosal is about 195 mm., and the greatest width across the squamosals is 145 mm. From the front of the beak to the orbit is probably about 48 mm., and the antero-posterior diameter of the orbit is about 43 mm. The interorbital width is 35 mm., and the intertemporal region 29 mm.

The type specimen is tuskless. The caniniform process is directed downwards and forwards and has a marked low outer ridge which passes upwards towards the jugal arch. Below the nostril is an anterior ridge parallel to the other and forming a well-marked valley between the two. The nostril is fairly large and the nasal is considerably thickened above it, forming an overhanging supranasal ridge.

The prefrontals are small, but the frontals are well developed. Posteriorly they enclose between them the small preparietal and meet the anterior ends of the parietals. The postfrontals are long and narrow. The preparietal is small and seems to lie entirely in front of the pineal foramen. The postorbitals are very large where they overlap the parietals, but the postorbital arch is unusually feeble.

The parietals are large and powerful, but are almost completely



hidden by the postorbitals. There has been a little doubt as to whether the pair of bones usually supposed (Seeley, Broom, etc.) to be parietals are really the parietals, or whether the median bone in which lies the pineal foramen, and usually called the preparietal (Seeley, Broom) or interparietal (Newton), may perhaps be the true parietal. This latter view has recently received the support of Jaekel. The median bone, called for convenience preparietal, is met with in most Anomodonts. In some (*Endothiodon*) it is very large; in others (*Cistecephalus*) it is quite absent. The size of the paired bones depends to a considerable extent on the development of the preparietal. In *Cistecephalus* there can hardly be any doubt that the large pair of bones behind the frontals are the parietals. They have the same relations to the squamosals, interparietal, frontals, and postorbitals as the parietals have in most reptiles, and there can be, I think, no reasonable doubt but that these bones are homologous with the parietals of the mammals. When the preparietal appears and the intertemporal region becomes narrowed the parietals are much reduced in front, but posteriorly the relations to the squamosals, interparietal, and postorbitals remain constant. In *Endothiodon* the preparietal is so large that the parietal seems to be completely separated from it by the frontal. In *Dicynodon*, as exemplified by this skull, the parietals still meet the frontals. What the preparietal is, is not clear. It certainly is not the interparietal. I am inclined to look on it as a neomorph developed in connection with the pineal eye. There is no trace of it known in Dinocephalians, Dromasaurians, Pelycosaur, Therocephalians, or Cynodonts, though in some of these the pineal eye was probably as large as even in *Endothiodon*.

There is little of special note in the palate or occiput.

The horizon from which the specimen was obtained is probably about 300 feet above that of Beaufort West.

EMYDOPS MINOR, gen. et sp. n. (Pl. XCIII. fig. 20.)

When Owen, in 1876, described the specimens of *Cistecephalus* in the British Museum, he named one species *Kistecephalus arctatus* and referred two specimens to it. The type differs very considerably from *Cistecephalus microrhinus*, the type species of the genus, and Lydekker in his Catalogue places *C. arctatus* doubtfully under *Cistecephalus*. On more than one occasion I have also expressed the opinion that *C. arctatus* does not belong to *Cistecephalus*.

Recently, I discovered at Kuilspoor a small imperfect skull which apparently belongs to the same genus as Owen's *C. arctatus*, though a distinct species. Pretty certainly the genus is not *Cistecephalus*, and the question arises, is it *Oudenodon*, or rather *Dicynodon*? The only specimens known are tuskless, and there are apparently no molar teeth. In the imperfect state of the specimens it is impossible to clearly differentiate the genus from

*Dicynodon* at present, but there seems little doubt they represent, if not a distinct genus, at least a subgenus. The more noteworthy characters are the wide parietal region with large parietals, slender postorbital arch, and feeble beak.

The length of the skull is probably about 45 mm., and the greatest breadth about 30 mm. The orbit measures 12 mm. in diameter. The intertemporal region is 14 mm. across.

The beak is in very imperfect condition, and little can be made out with certainty as to its structure. It may be stated with confidence that it was short.

The frontals are large, and form an interorbital region 10 mm. wide. From near the supraorbital margin to the anterior end of the parietal there runs backwards and slightly inwards a shallow groove. There is a moderate sized triangular postfrontal and a large median preparietal. This latter seems to lie entirely in front of the pineal foramen. The parietals are large and form the greater part of the broad intertemporal region. The postorbital is long and slender. It forms a feeble postorbital arch and the inner margin of the temporal fossa. The squamosal is of the typical *Anomodont* type. Its zygomatic position extends forwards to below the orbit. The articular region is badly preserved.

The lower jaw is very like that of *Oudenodon*, but the beak portion is small, and probably little more than the symphyseal region was covered with horn.

#### Suborder CYNODONTIA.

*ICTIDOPSIS ELEGANS*, gen. et sp. n. (Pl. XCIII. fig. 22.)

This new genus and species is founded on a nearly perfect little skull obtained at Harrismith, Orange River Colony. It is a very near ally of *Nyctosaurus lervatus* Owen, but is much smaller, and differs in the number of molars and in other cranial characters.

In general shape the skull agrees fairly well with *Nyctosaurus*. The orbit is near the middle of the skull and relatively larger than in the better known genus, while the jugal arch is more slender. In *Ictidopsis* the snout is shorter, and the molars are 6 in number instead of 7.

The greatest length of the skull is probably 63 mm. and the width is 42 mm. The interorbital width is 12.5 mm.

The premaxillary bone is badly preserved, but it is manifest that there are four incisors. The first three incisors are moderately round, but the last is more flattened. There do not appear to be any posterior serrations.

The maxillary is relatively shorter than in *Nyctosaurus*, and deeper. Above the canine, and in front of the lachrymal are little elevations of the bone. On the canine elevated area are three small foramina and near the root of the 3rd molar two other

foramina, while two more are near the anterior end of the bone. As there is no single large supra-maxillary foramen, it is probable that all these small foramina are for branches of the maxillary nerve. The canine is long and slender. It is ridged somewhat after the manner of the canine of the cat. Behind it are 6 molars. The 1st is small, pointed, and without any cusps. The 2nd, 3rd, 4th, and 5th all closely resemble one another. There is a large pointed median cusp and a small anterior and posterior cusp. While essentially similar in type to the molars of *Nythosaurus* they differ in that the anterior and posterior cusps are relatively smaller. The 6th molar is a small tooth, and unfortunately the crown has been lost from both sides of the skull.

The incisors measure about 6.5 mm. Behind the last incisor is a diastema of 4 mm. The canine measures antero-posteriorly about 2.5 and its height is 7 mm. At a distance of 1.5 mm. behind the canine is the 1st molar, and the whole series of six occupies the space of 13 mm.

Only a small fragment of the septo-maxillary is preserved, but it manifestly forms part of the face, and was probably as in *Nythosaurus*.

The nasal is moderately wide in front, but narrows on passing backwards, and then near its middle it becomes about twice as wide as in front. Round the bone near where it meets the maxilla is a series of three or four foramina.

The lachrymal forms the front of the orbit and, as in *Nythosaurus*, it is larger than the prefrontal.

As in *Nythosaurus* and most Cynodonts the prefrontal meets the postorbital, shutting out the frontal from the orbital margin. The postorbital forms about half of the postorbital arch and overlaps a small part of the parietal.

The parietal is large, and there is an obvious pineal foramen.

The squamosal is like that of *Nythosaurus*, except that in *Ictidopsis* there is a much more prominent auditory groove.

The fractured edge of the occipital crest shows the interparietal distinct from the parietals, and the lateral bone, which I believe to be the opisthotic, distinct from the parietal, the interparietal, and from the squamosal.

The occiput and palate have not been cleared.

The dentaries are in position, but the posterior bones of the jaw have been detached and displaced, probably by insects before the skull was fossilized.

The type of *Ictidopsis elegans* was found at Harrismith in association with *Lystrosaurus*. Unfortunately the geology of Harrismith is unknown. Some of the first specimens of South-African Dinosaurs were got there by Mr. J. M. Orpen in 1853, and there can be no doubt that these are from the Red Beds of the Stormberg Series. It is not a little startling to find that the same commongage yields fossils which in Cape Colony belong to a horizon about 3000-4000 feet lower than the Red Beds. Probably the Molteno

Beds and the Burghersdorp Beds are greatly thinned out, or possibly there is an unconformity.

Some years ago I divided the Upper Beaufort, or Triassic Beds, into three zones: (1) the *Lystrosaurus*-Zone, (2) the *Procolophon*-Zone, and (3) the *Cynognathus*-Zone. While these zones in the main hold good, the limits of them are still unknown. In the extensive *Lystrosaurus* beds of Colesburg, Middelburg, and Cradock no *Procolophons* or *Cynodonts* are known; but Mr. D. M. S. Watson has recently found *Lystrosaurus* associated with *Cynodonts* to the west of Burghersdorp, and a similar association we now know occurs at Harrismith. Again, while no *Lystrosaurus* or *Cynodont* remains are certainly known from the *Procolophon* beds, the *Procolophon*-like genus *Thelognathus* occurs at Aliwal North with *Cynodonts*, and possibly *Procolophon* itself. It seems not improbable that later work will further subdivide the Triassic Beds, each zone counting from the point where a new type begins, but before we can make any further advance with confidence we require to have a much fuller knowledge of the distribution of the fossils of the Upper and Middle Trias.

In the meantime I think we are safe in stating that *Nythosaurus*, *Ictidopsis*, and probably *Galesaurus* come from an older zone than the *Cynognathus* beds. None of the known specimens have been found near Burghersdorp, nor have any traces of *Lystrosaurus* ever been found, from which we may conclude that *Lystrosaurus* and probably these small *Cynodonts* became extinct before *Cynognathus* appeared.

*NYTHOSAURUS* BROWN, sp. n. (Pl. XCIII. fig. 23.)

This new species is founded on an imperfect lower jaw obtained by Mr. Alfred Brown at Aliwal North. A large part of both dentaries is present, but most of the symphyseal portion is missing with the canines and incisors. Five molars are well preserved on the left side and three on the right.

While in a number of respects the specimen differs from *Nythosaurus larratus* Owen, it seems probable from the position of the symphysis that there were seven molars, and as in general structure the molars agree with those of *Nythosaurus larratus*, we may consider it as probable that the species belongs to this genus.

The dentary differs from that of *Nythosaurus larratus* in having a more slender horizontal ramus, in having a more marked angle, and in the ascending ramus passing more upwards.

The molars preserved are probably the 3rd to the 7th. All have three cusps. What is apparently the 3rd molar has the median cusp short, and the others only feebly developed. In the 4th and the other later molars the middle cusp is about twice as long as the anterior and posterior cusps. In the second last molar there is an additional small anterior cusp which gives it four cusps, but there appear to be only three cusps in the last molar. The five molars occupy 13.5 mm.

Though the crowns of the molars resemble considerably those of the Triconodont mammals there is the marked difference that in *Nythosaurus* there is no trace of a cingulum, and there is apparently only a simple root to each tooth.

ADDENDUM (29th July, 1912).—Since the above paper was read evidence has been obtained which shows that the genus *Endothiodon* must be subdivided. Seeley twenty years ago placed *Endothiodon uniseries* in a distinct genus, *Esoterodon*, and until quite recently I have followed him in this. A fragmentary maxilla recently found by Mr. Whaits shows that Seeley was correct. In *Endothiodon bathystoma* the teeth have long pointed crowns with coarse serrations both in front and behind. In *Endothiodon uniseries* the teeth have flattened crowns serrated only behind, and in *Endothiodon platyceps* there are no serrations on either side. This latter point has been confirmed in a second specimen. Until the crowns of the teeth of *Endothiodon whaitsi* are known we may provisionally place it with *Endothiodon uniseries*. The group would thus be formed of

*Endothiodon bathystoma* Owen.

*Esoterodon uniseries* Owen.

*Esoterodon whaitsi* Broom.

*Emydochampsia platyceps* Broom, gen. nov.

#### EXPLANATION OF THE PLATES.

##### PLATE XC.

- Fig. 1. Side view of snout of *Taurops macrodon* Broom. Nearly  $\frac{1}{2}$  nat. size.  
 Fig. 2. Side view of tooth of probably *Eccasaurus priscus* Broom. Nat. size. This tooth, though not associated with the type of *Eccasaurus priscus*, is from the same horizon, and as it is the tooth of a Dinocephalian of the size of *Eccasaurus* it very probably belongs to this genus and species.  
 Fig. 3. Upper view of tooth of probably *Eccasaurus priscus* Broom. Nat. size.  
 Fig. 4. Side view of skull of *Scymnognathus whaitsi* Broom. A little over  $\frac{1}{2}$  nat. size. The skull is much flattened and distorted by crushing.  
 Fig. 5. Lower jaw of *Scymnognathus whaitsi* Broom.  $\frac{1}{2}$  nat. size. Though this jaw is rather smaller than that of the type specimen it almost certainly belongs to this species. It may have belonged to a young animal or to a female. The specimen is considerably crushed.

##### PLATE XCI.

- Fig. 6. Side view of the skull of *Galeops whaitsi* Broom. Nat. size. The specimen is slightly crushed and considerably weathered. The orbital margins and the preorbital portion of the skull and the lower jaw are the outer surface of the bones viewed from within. The back portion of the skull shows the quadrate and parts of the squamosal and opisthotic. A sclerotic plate is seen in the orbit.  
 Fig. 7. Side view of snout of *Elurosaurus striatidens* Broom. Nat. size. The specimen is considerably crushed.  
 Fig. 8. Side view of snout of *Pristerognathus platyrhinus* Broom.  $\frac{1}{2}$  nat. size.  
 Fig. 9. Under view of snout and lower jaw of *Alopecorhinus parvidens* Broom.  $\frac{1}{2}$  nat. size.  
 Fig. 10. Upper view of imperfect skull of *Ictidognathus hemburyi* Broom. Nat. size.  
 Fig. 11. Under view of snout of *Ictidognathus hemburyi* Broom. Nat. size.

## PLATE XCII.

- Fig. 12. Upper view of skull of *Dicynodon laticeps* Broom.  $\frac{5}{18}$  nat. size.  
 Fig. 13. Under view of snout of *Dicynodon laticeps* Broom.  $\frac{5}{18}$  nat. size.  
 Fig. 14. Side view of skull of *Dicynodon lutriceps* Broom.  $\frac{5}{12}$  nat. size. The contact between the front part of the skull and the occiput is missing, but the relation of the parts must be almost as restored.  
 Fig. 15. Upper view of skull of *Dicynodon lutriceps* Broom. About  $\frac{5}{16}$  nat. size.  
 Fig. 16. Palatal view of skull of *Dicynodon lutriceps* Broom. About  $\frac{5}{16}$  nat. size.  
 Fig. 17. Upper view of skull of *Dicynodon psittacops* Broom. About  $\frac{5}{12}$  nat. size.

## PLATE XCIII.

- Fig. 18. Side view of skull of *Endothiodon whaitsi* Broom. About  $\frac{2}{3}$  nat. size.  
 Fig. 19. Upper view of lower jaw of *Endothiodon platyceps* Broom. About  $\frac{5}{15}$  nat. size.  
 Fig. 20. Upper view of skull of *Emydops minor* Broom.  $\frac{5}{16}$  nat. size.  
 Fig. 21. Side view of skull of *Prodicynodon beaufortensis* Broom. About  $\frac{7}{10}$  nat. size.  
 Fig. 22. Upper view of skull of *Ictidopsis elegans* Broom.  $\frac{5}{16}$  nat. size.  
 Fig. 23. Side view of left dentary of *Nyctosaurus browni* Broom.  $\frac{5}{16}$  nat. size.

53. On the Hydrocoralline Genus, *Errina*. By Professor S. J. HICKSON, F.R.S., F.Z.S., The University of Manchester.

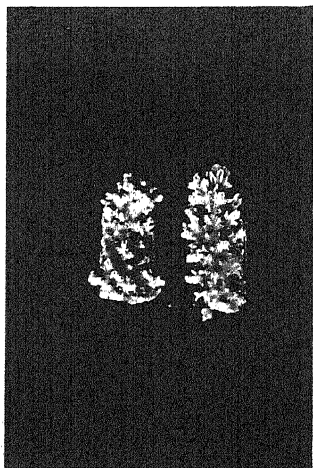
[Received April 29, 1912: Read June 4, 1912.]

## (Plates XCIV.-XCVI.)

INDEX.	Page
Revision of the genera <i>Errina</i> , <i>Labiopora</i> , <i>Spinipora</i> .....	877
Description of new species .....	882
Notes on the structure of <i>Errina novæ zelandiæ</i> ..	884
Note on geographical distribution .....	886
Description of old species .....	887
General remarks on structure .....	891
List of known species .....	893
Additional notes .....	894
Literature .....	894
Explanation of the Plates .....	895

Four years ago Professor Benham sent to me some specimens of Stylasterina from New Zealand, with a request that I would name them for him. At the same time he forwarded some notes and drawings which have proved to be of considerable assistance to me in working out their details. I am also indebted to Professor Dendy for the loan of another specimen also from New Zealand; to the late Mr. Morgan, of Worthing, for the loan of a specimen from an unknown locality; and to Mr. Gilchrist for a specimen from the Cape of Good Hope.

All these specimens clearly belong to one of three genera, *Errina*, *Labiopora* or *Spinipora*, as they exhibit the characters that these genera exhibit in common and by which they can be separated from other Stylasterina. These characters are: (1) a



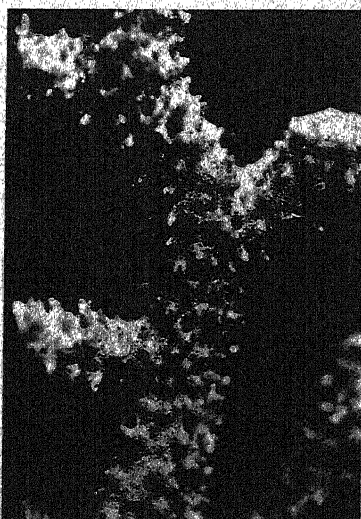
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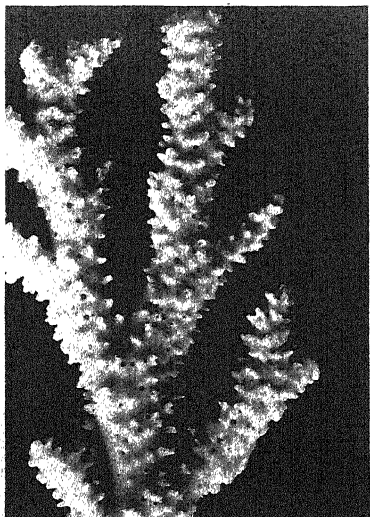
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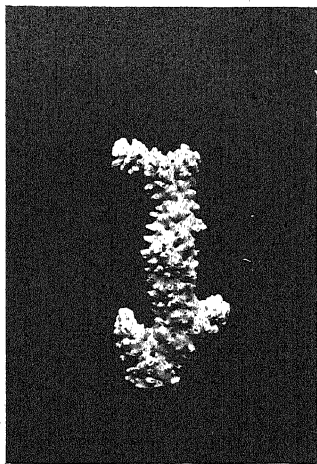
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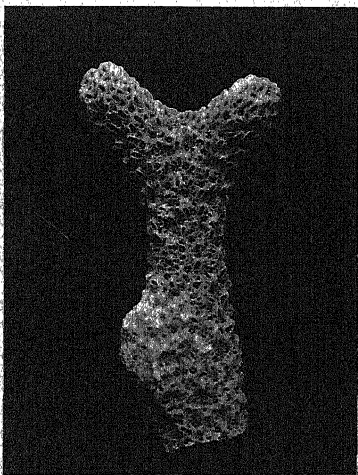




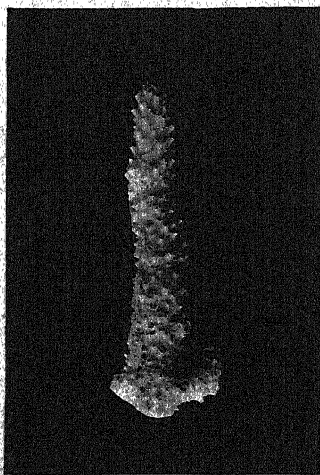
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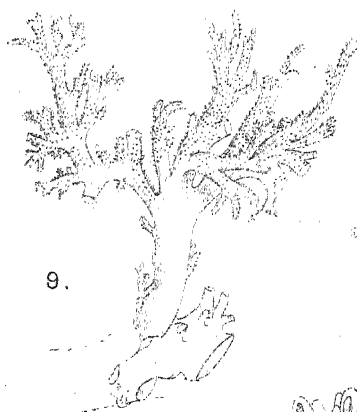


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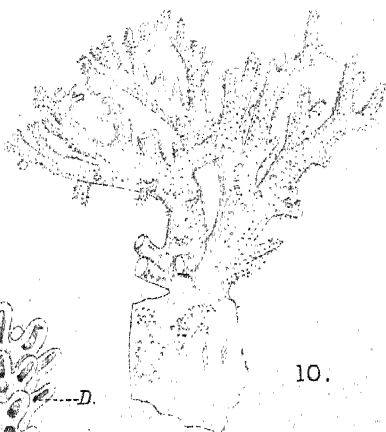


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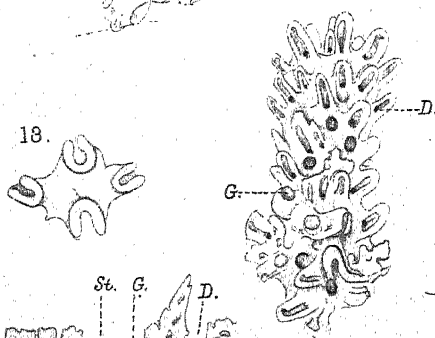




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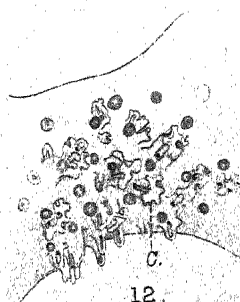
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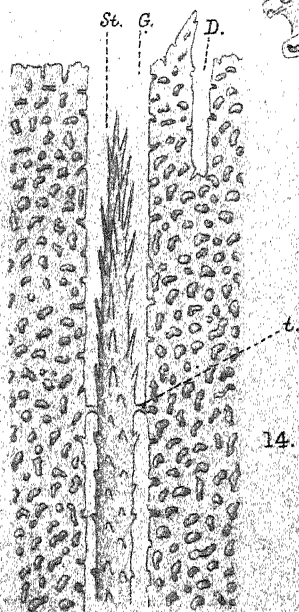
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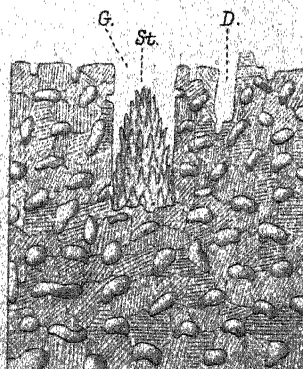
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12.



14.



15.

HYDROIDS OF THE GENUS ERRINA.

Edw. Little London.



style in the Gasteropores; (2) no style in the Dactylopores; and (3) the Dactylopores, or some of the Dactylopores, guarded by a grooved lip or spine—called by Moseley the “nariform process.”

To any one acquainted with Moseley’s classical memoir of the Stylasterina (8), and with the subsequent literature, which is not very extensive, it might seem a simple matter to determine whether the specimens about to be described belong to any one of the three genera or not; because, according to Moseley’s descriptions, the following characters were diagnostic:—

*Errina*, with only one kind of Dactylopore.

*Labiopora*, with two kinds of Dactylopores. The larger kind of dactylopore with a nariform process\* and arranged in rows. The smaller kind of dactylopore, without a nariform process, arranged between the rows.

*Spinipora*, also with two kinds of Dactylopores. The larger kind of dactylopore with long grooved spines, not arranged in rows. The smaller kind of dactylopore at the base of the larger ones.

Moseley’s memoir was published in 1881, and since that date only four new species of *Errina* and one new species of *Labiopora* (*L. moseleyi*) have been described; but owing to the rarity of these Hydrocorallines in the seas that have been recently investigated, very little progress has been made in our knowledge of them.

The specimens from New Zealand and elsewhere that I have examined convinced me that a thorough revision of the genera was necessary, and consequently the task of naming Professor Benham’s specimens has taken me much longer than I anticipated. The general results of my investigations have been to show that the limits or frontiers between the three genera are ill-defined and that it is necessary to accept von Marenzeller’s (6) proposal to unite *Labiopora* with *Errina*.

In the first place, I have found, as von Marenzeller (6) has done, that the presence of two kinds of dactylopores is not a very reliable character; because in some forms that are otherwise closely related the dactylopores of the smaller kind that have no grooved spines may be numerous, scarce, or altogether absent (e. g., *Errina novæ zelandiæ*). A genus such as *Labiopora* cannot therefore be absolutely separated from *Errina* by the character of the dimorphism of the dactylozooids.

Moreover, the arrangement of the grooved spines in definite rows is another character that is subject to considerable variations and cannot be relied upon for diagnostic purposes. The arrangement of these processes seems to be correlated in some way with the method of growth of the hydrophytum as a whole, and that is again, I believe, dependent upon the conditions of the environment.

\* The term “nariform process” introduced by Moseley is not very convenient, and I have consequently used the expression “grooved spine” for the ctenostean processes that shelter the dactylozooids.

The characters that appear to me of more importance and to signify a more profound differentiation are based upon:—

1. The texture of the surface of the corallum.
2. The aspect of the grooves in the nariform processes.

Moseley described the surface of *Errina* as composed of a compact, hard, glistening, white, calcareous tissue, and he adds that the canals generally are in this genus larger in proportion to the size of the zooids than in most other forms, and the mesh-works formed by them are comparatively wide open. Associated with these two characters we usually find that the surface is marked by shallow longitudinal grooves perforated by a series of small apertures through which the vertical canals pass. These cœnosteal pores are well defined in the species of this group that I have examined, and in the type specimens of *E. labiata* and *E. ramosa* they are about .05 mm. in diameter. The surface of *Spinipora* is hard and compact as in *Errina*, and it is also perforated by well defined cœnosteal pores.

In the original description of the genus *Labiopora*, Moseley describes the cœnosteum as being "minutely reticulate in texture," and in the description of *Labiopora moseleyi* Ridley (10) also describes the surface as being "minutely reticulate." In all the specimens I have examined there is a very marked contrast between the surface of the specimens now included in the *Labiopora* group of species and of those I propose to retain in the *Errina* group.

I should prefer to describe the surface of the former group of species as being "granular" rather than "reticulate." In *Errina* (*Labiopora*) *capensis* it is coarsely granular and in all the other species of the group it is minutely granular (cf. Pl. XCVI. figs. 14 & 15). Below the surface, the cœnosteum is minutely reticulate, being perforated by a network of small-meshed canal passages (fig. 14), in contrast with the wide-meshed canal passages of the *Errina* group.

As regards the grooved spines. In the following species that I have examined the groove in the spine that protects a dactylopore is turned towards the apex of the branch on which it is situated: *E. labiata*, *E. horrida*, and *E. ramosa*. The groove has the same aspect in *E. glabra* and *E. carinata*, if we may judge from the figures given by Pourtales (9).

In the only two specimens of the genus *Spinipora* that are known the grooves also turn towards the apex of the branch (Pl. XCV. fig. 8). In the *Labiopora* group of species there is considerable variation in the direction of the grooves. In some of them, all or nearly all the grooves are turned away from the apex (Pl. XCVI. fig. 11), but in others the grooves are turned in all directions, the grooved spines forming irregular clusters on the surface (Pl. XCVI. figs. 12 & 13). The same arrangement of the grooves occurs in *Errina gracilis* and in *Errina macrogastra*, according to von Marenzeller, who writes "Ihre Oeffnung ist nach hinten gerichtet, selten seitlich" (5), and also in *Errina fissurata* of Gray (2).

Taking these characters as guides it seemed to me that the diagnostic characters of the three genera might be stated as follows:—

- (a) Cœnosteum hard and compact, perforated by well-defined cœnosteal pores. Grooved spines turned towards the apex of the branch.
  - 1. With short grooved spines and only one kind of dactylopore ..... *Errina*.
  - 2. With long grooved spines and two kinds of dactylopores..... *Spinipora*.
- (b) Cœnosteum granular and reticulate, without well-defined cœnosteal pores. Grooved spines turned away from the apex of the branches or irregularly placed ..... *Labiopora*.

If the three genera be joined together to form a subfamily, the Errinina, this subfamily might be defined as follows:—

Hydrophytum arborescent and irregularly flabelliform, gastropores and dactylopores not arranged in cyclosystems. Gastropores with a large brush-like style. Dactylopores without a style. Some of the dactylopores protected by a grooved spine (narial process) on the surface of the cœnosteum.

This arrangement of the genera, however, breaks down on further analysis, and I see no other course than to arrange all the species in three groups under the one generic name *Errina*.

The genus *Errina* was founded by Gray in 1835 for a species of coral found in the Mediterranean Sea and formerly called *Millepora aspera* by Linnæus.

As von Marenzeller has pointed out, Gray's description of the spines in this species as "Superne longitudinaliter fissæ" is not consistent with the description of the species known to Linnæus and Esper.

I have examined the type specimens in the British Museum, and have found that Gray's description is not correct. The spines in these specimens are irregular in arrangement, but where they are isolated and not in clusters the groove is directed *away* from the apex. Moreover, the character of the surface of the cœnosteum, the presence of a few small dactylopores without grooved spines, and other features prove that this species is more closely related to the type species of *Labiopora* than it is to any of the other species of *Errina*.

According to the system I had, at first, proposed the type species of *Errina* would thus be a species of *Labiopora* and Moseley's *Errina ramosa* would become the type species of the genus.

Such a proposal, therefore, would not only be contrary to the rule of zoological nomenclature, but it would also be extremely inconvenient. Moreover, one species at least (*E. macrogastra*) would occupy an intermediate position, having a surface similar

to that of *Errina* and grooved spines similar to those of *Labiopora*.

A plea might still be made to keep the genus *Spinipora* distinct, but I am convinced that intermediate forms will be found between the deep-sea species of *Errina* and the only known species of *Spinipora*, and that sooner or later it will be found impossible to keep it apart from the others.

In the following pages, therefore, I have regarded all the species that have been attributed to the three genera as belonging to the one genus, *Errina* of Gray, but for convenience of reference I have added after the generic name (*Labiopora*) or (*L.*) in the case of those species that were formerly described as belonging to the genus *Labiopora* and to others that belong to that group of species, and (*Spinipora*) or (*S.*) in the case of *Errina echinata*, the only known species of the *Spinipora* group.

#### Genus ERRINA Gray.

With the characters of the subfamily Errinina (p. 879).

##### The "*Errina*" group of species.

Cænosteum hard and compact, perforated at the surface by well-defined cænosteal pores usually arranged in rows in shallow longitudinal surface-grooves. Gasteropores with or without a scale. All the dactylopores protected by short grooved spines (narial processes) with the grooves turned towards the apex of the branch.

The only species of this group that have been sufficiently well described to make identification possible without reference to the type specimens, are *Errina labiata* Moseley and *E. ramosa* Hickson & England and *E. horrida* H. & E. Other species are *Errina carinata* Pourtales and *E. pourtalesii* Dall. Pourtales in 1871 described three species, which at first he placed in the genus *Errina* but subsequently transferred them to a new genus, *Lepidopora*. These species were referred back again to *Errina* by Moseley. Their names are *E. glabra*, *E. cochleata*, and *E. dabneyi*. These three species were distinguished from *Errina* by the presence of a lip or lid-like process similar to that of *Cryptohelia* hanging over the gasteropores. *Errina fissurata* of Gray may have been a specimen of *Labiopora*, but as the original specimen has been lost it is useless to speculate on its supposed affinities.

The species may be arranged as follows:—

\* a. Gasteropores with a definite lip or scale:—

*E. glabra*, *E. cochleata*, *E. dabneyi*, and *E. ramosa*.

b. Gasteropores in the angles formed by the branches:—

*E. horrida*.

c. Gasteropores without scales and distributed on the surface of the cænosteum:—

*E. labiata*, *E. carinata*, *E. pourtalesii* (?).

\* See Note p. 894.



As regards the distribution it may be said that all the species are inhabitants of deep water (*i. e.* 50–600 fathoms). Being deep-sea species they are probably widely distributed, but at present *E. pourtalesii*, *E. ramosa*, and *E. horrida* have only been found in the Pacific Ocean and Malay Archipelago, and the remaining species in the Atlantic Ocean.

*Spinipora* group of species.

Cænosteum hard and compact, perforated at the surface by well-defined cænosteal pores usually arranged in shallow branching grooves irregularly arranged on the surface. Gasteropores without a scale. Dactylopores of two kinds. The larger kind being guarded by long grooved spines (narial processes) crowded and overlapping on the terminal branches, often worn down short and separated by considerable intervals on the stems and older branches (Pl. XCV. fig. 8). All the grooves of these spines turned towards the apex of the branch. Smaller dactylopores not protected by grooved spines, but scattered between and on the projections that guard the larger dactylopores.

The *Spinipora* group is represented by only one species, *Errina* (*S.*) *echinata* Moseley, and this species has been found off Rio de la Plata in 600 fathoms by the 'Challenger' Expedition, and off Providence Island in the Indian Ocean in 75 fathoms by Professor Stanley Gardiner (4).

*Labiopora* group of species.

Cænosteum granular and minutely reticulate, without clearly defined cænosteal pores. Gasteropores without scales but sometimes protected by short grooved projections or "lips." Dactylopores protected by grooved spines of variable lengths, the grooves turned away from the apex of the branch or irregularly in all directions. Some of the dactylopores usually without grooved spines.

The species of this group that have been described already are *Errina aspera* Gray, *Errina* (*Labiopora*) *antarctica* Gray, *Errina* (*L.*) *moseleyi* Ridley, and *Errina gracilis* von Marenzeller.

*Errina aspera* was the name given by Gray to the Linnean species *Millepora aspera* from the Mediterranean Sea. *Errina* (*L.*) *antarctica* was originally described by Gray as a Polyzoon (*Porella antarctica*), but was subsequently redescribed and figured by Moseley as the type species of *Labiopora*. The type specimen was found off the East coast of Tierra del Fuego, but a second specimen was discovered by the 'Alert' Expedition in 30 fathoms off S.W. Chili and described by Ridley (10). *Errina* (*L.*) *moseleyi* was found by the 'Alert' Expedition off the same coast in 2–10 fathoms. *Errina gracilis* was found off the pack ice in the Antarctic Ocean in deep water (von Marenzeller) (6).

I have had an opportunity of carefully examining a piece of

the type specimen of *Errina* (L.) *antarctica* and comparing it with the specimens from various localities mentioned at the beginning of this paper. I have found, as I expected, the same difficulties in the determination of species that are met with in the systematic zoology of other zoophytes. My impression is that all the specimens from New Zealand belong to one distinct species, that the specimen from the Cape of Good Hope belongs to another distinct species, and that both these species are distinct from the four species that have already been described. But there is so much variation in the specimens from New Zealand that it is clearly desirable to have a careful description of each. I have also added for convenience' sake a new description of the two earlier species for comparison.

*ERRINA* (LABIOPORA) NOVÆ ZELANDIÆ. (Facies *Ramosa*.) (Pl. XCIV. fig. 3 & Pl. XCVI. fig. 9.)

This specimen was obtained from Preservation Inlet, W. coast of South Island of New Zealand, in about 3 fms. of water, and was lent by the Canterbury Museum to Prof. Benham. The colony is flabelliform, with profuse ramification but without anastomoses. The terminal branches are usually delicate. This may be expressed in figures by saying that at a distance of 3 mm. from the extremity of a terminal branch the diameter may be not more than 1 mm. The larger branches are slightly compressed in the plane of the flabellum; the others circular in section.

Colour: salmon-pink\*.

Surface minutely granular, substance of the cœnosteum minutely reticulate.

Grooved spines (narial processes) numerous, arranged in rows, rarely in clusters. The groove, in nearly all cases, turned directly away from the apex of the branch.

Gasteropores more numerous on one side of the flabellum than on the other, sometimes provided with a lip. Diameter of gasteropores 0.27 mm.

Large dactylopores  $0.06 \times 0.16$  mm. (The large kind of dactylopores of the genus are protected by the grooved spines, and the measurements given indicate approximately the width  $\times$  depth of the groove at its deepest part.)

Small dactylopores rare or absent. The small dactylopores are often difficult to determine until the coral is thoroughly cleaned by boiling in eau de javelle. I have examined and re-examined a small branch thus cleaned and can find no small dactylopores, but as I have only a small amount of material at my disposal, and as Benham states in his MS. notes that the small dactylopores are "rare," I cannot deny their existence.

\* There are so many shades of red to be found in corals that I have used the technical term which expresses the shade of red that comes nearest to that shown by this coral.

ERRINA (LABIOPORA) NOVÆ ZELANDIÆ. (Facies Benhami.)  
(Pl. XCIV. figs. 1 & 2; Pl. XCVI. fig. 13.)

This specimen was also found in Preservation Inlet and lent to Prof. Benham by the Colonial Museum. One branch of this specimen was well preserved in spirit. The colony is flabelliform, with profuse ramification and abundant anastomoses. The terminal branches are thick, the diameter of such a branch at a distance of 3 mm. from the extremity being about 3 mm. All the branches are approximately circular in section.

Colour: salmon-pink.

Surface minutely granular and substance minutely reticulate.

Grooved spines numerous, arranged roughly in rows. These spines are more numerous and longer than in the facies "Ramosa." They are, moreover, frequently arranged in clusters, so that they have the appearance of "branched spines" (fig. 13). The grooves are in general turned away from the apex, but when the projections are clustered they turn in all directions.

Gasteropores equally numerous on the two sides of the flabellum. Without a lip. Diameter varying considerably from 0.13 mm. to 0.17 mm.

Large dactylopores  $0.06 \times 0.16$  mm.

Small dactylopores not infrequent, 0.05 mm. in diameter.

ERRINA (LABIOPORA) NOVÆ ZELANDIÆ. (Facies Dendyi.)  
(Pl. XCIV. fig. 4.)

This specimen was obtained in Milford Sound, W. coast of South Island, and was lent to me by Professor Dendy.

It is not very profusely branched, but probably has a flabelliform mode of growth. The terminal branches are delicate and of approximately the same diameter as those of facies "Ramosa." There are no anastomoses in the specimen.

Colour: salmon-pink.

The surface is minutely granular and the substance minutely reticular.

Grooved spines not very crowded but quite irregularly disposed, not in rows, never in clusters. The groove in all cases turned away from the apex of the branches.

Gasteropores on both sides of the branches but rather more numerous on one side than the other. Usually guarded by a small lip. Diameter 0.22 mm.

Large dactylopores  $0.06 \times 0.11$  mm.

Small dactylopores 0.05 mm. in diameter, usually guarded by a shallow collar or lip.

A feature of this specimen that should be mentioned is the suppression of the spines on the larger branches. Only the terminal branches are echinate.

ERRINA (LABIOPORA) NOVÆ ZELANDIÆ. (Facies Cooki.)  
(Pl. XCV. fig. 5; Pl. XCVI. figs. 10, 11, 12.)

This specimen was obtained from the cable in Cook Straits between the two islands of New Zealand, and was lent to Professor Benham by the Colonial Museum. According to Professor Benham's notes, two specimens were obtained, one being 50 mm. in height  $\times$  70 mm. across, and has six main branches; the other is smaller, 30 mm. in height  $\times$  60 mm. across. The general form of the cœnosteum is flabellate, the main axis flattened but the branches circular in section. The branches do not anastomose in the specimen examined. Only a small piece of one of these colonies was sent to me, and from that I have drawn up the following notes.

Colour: pure white.

Surface and substance as in the other facies.

Grooved spines not very crowded and not arranged in definite rows, frequently in clusters with the grooves pointing in all directions (fig. 12).

Gasteropores evenly distributed on both sides of the flabellum, without any lip or collar, 0.22 mm. in diameter.

Large dactylopores 0.06  $\times$  0.08 mm.

Small dactylopores rare or very rare, 0.09 mm. in diameter.

In comparing these four facies of the species, several points of interest may be observed.

They all agree in the general texture of the cœnosteum, and they all have a more or less flabellate form of growth.

As regards the size of the hydrophytum as a whole, it is impossible, owing to the broken condition of all the specimens examined, to give exact measurements. A specimen of uncertain facies in the Colonial Museum is 90 mm.  $\times$  70 mm. (according to the MS. notes of Professor Benham), the specimen of the facies "Cooki" was 50 mm. in height  $\times$  70 mm. in expanse. Judging from these figures and from the size of the branches of the other specimens, it seems probable that the normal size of a full-grown specimen of the species is not more than 100 mm.  $\times$  100 mm., or that, in words, it is a coral that does not normally attain a very large size.

Of the other characters, perhaps the most important one to consider is the dimorphism of the dactylopores, because this character has been used as a diagnostic character for the separation of the genera *Labiopora* and *Errina*. In the facies "Benhami" and "Dendyi" there are clearly many small dactylopores lying on the general surface of the cœnosteum between the grooved spines and distinct from the larger dactylopores. In the facies "Ramosa" no such dactylopores could be found in the specimen I examined (although Professor Benham says they are rare), and in the facies "Cooki" they are certainly very rare. With the many points of resemblance in form, colour, size of pores, etc. between the two facies "Ramosa" and "Benhami," it would be

very rash to propose that they should be separated into distinct species on account of this one character.

It seems to me, therefore, that the presence of small dactylopores in addition to the dactylopores of the ordinary type, in other words, the character of dimorphism in the dactylopores, is not a character that should be regarded as absolutely diagnostic either of the genus or of any one of its species.

As regards the gasteropores there seem to be some variations. In "*Benhami*" the gasteropores vary considerably in diameter from 0.13–0.17 mm., but in "*Ramosa*," "*Cooki*," and "*Dendyi*" they are more constant in diameter, being 0.27 mm. in the first named, and 0.22 mm. in the latter. It is probable that these figures are not of much value for systematic purposes. There are many technical difficulties in the way of making accurate measurements of the mouths of a large number of gasteropores on any single specimen, and unless the average diameter of a large number of gasteropores of one specimen can be compared with similar averages from other specimens of the same facies or species, the figures given simply represent a statement of fact concerning a given specimen. The real value of the figures I have given is that they prove that the diameter of the gasteropores is a variable quantity and cannot be used, except in a very general way, as a guide to the determination of species. One point of rather special interest is that in the facies "*Ramosa*" with slender terminal branches the gasteropores appear to be actually larger than they are in "*Benhami*" with thicker terminal branches. This seems to indicate that there is no relation between the thickness of the branches and the size of the gasteropores, since the expectation would be that the stouter terminal branches would bear the larger gasteropores.

The presence of a raised margin on one side of the gasteropores in some of the specimens of this species is a feature of some general interest. In some of the gasteropores of the facies "*Ramosa*" these processes are of considerable size, and bending over the pore have an appearance very similar to the lid of a *Cryptohelia*. In "*Dendyi*" they are rudimentary, but in the other specimens they are absent.

The presence of a definite lip or scale on the edge of the gasteropore, it must be remembered, was the principal character relied upon by Pourtales for the separation of the genus *Lepidopora* from the genus *Errina*, but if we accept Moseley's view that the species of *Lepidopora* should be incorporated with *Errina*, then we have a parallel series of variations as regards this character in the *Errina* group, to that in the *Labiopora* group.

At one time I thought that the difference in the length of the grooved spines (nariform processes) might be a useful character for the separation of the species in this genus. In all the specimens, however, I found that the projections on the young actively growing terminal branches are longer than they are on the older branches, and consequently there is a difficulty in fixing a standard

of measurement for comparison. Taking the measurement of a few of the projections at a distance of about 3 mm. from the apex of the branches, I have found that the average is in "Benhami" 0.7 mm., and in "Dendyi" 0.4 mm., the projections in "Ramosa" and "Cooki" being intermediate in size between these two measurements. The differences between these averages are so small, and the difficulty of avoiding a relatively large error in the calculation is so great, that the measurements are of no more scientific value than to express roughly the general impression of observation that the projections are longest in "Benhami," shortest in "Dendyi," and of medium length in other specimens. The longest projections in "Benhami" are, however, not simple nariform processes as they are usually in the other facies, but groups of two, three or four of these processes clustered together (fig. 13). The clustering together of the grooved projections may be seen in some of the other facies, such as "Ramosa" and "Cooki," but it is never such a pronounced feature as it is in "Benhami."

Lastly, a word about geographical distribution. All the specimens were dredged off the coast of New Zealand, and two of these four were found in the same bay (Preservation Inlet). There is every reason to believe, moreover, that they were all found in shallow water. In my opinion these facts have some weight in determining the question whether the specimens should be placed in one species or in several species. In a rare genus such as *Errina*, species found at widely separated localities will in all probability be affected by their isolation and show differences that entitle them to rank as distinct species, but there is much less probability that the genus would be able to develop or to maintain specific differences in the same waters. Unless, therefore, a very clear case is made out that the differences between the specimens of the genus *Errina* from New Zealand waters are constant or of fundamental importance, the most convenient as well as most scientific course to pursue is to place them together in the same species.

*ERRINA (LABIOPORA) CAPENSIS*, sp. n. (Pl. XCV. fig. 7; Pl. XCVI. fig. 15.)

This species is represented in my collection by three broken terminal branches. The largest piece is 36 mm. in length, the diameter at the base is 7 mm., and the diameter of the branch 3 mm. from the apex is 4.5 mm. In the largest specimen of the New Zealand species ("Dendyi") the diameter at the base (evidently the base of attachment) is 6 mm., and the diameter of a branch 3 mm. from the apex is only 2 mm.

From these facts it seems probable that in this species the hydrophytum reaches to much greater dimensions than does that of the New Zealand species.

The branches terminate in blunt, slightly flattened and expanded extremities.

The hydrophytum is probably flabellate in growth, the ramification not very profuse and anastomoses rare.

Colour: salmon-pink.

Surface coarsely granular and substance coarsely reticulate.

As this species seems to approach the *Errina* group in some respects, attention may be called to the striking difference there is between the coarsely granular character of its surface and the fine smooth porcellaneous character of the surface of the *Errina* group.

Grooved spines very short, numerous, quite irregular in arrangement and never in clusters. The form of the spine is that of a shallow semicircular ridge open on the side turned away from the apex.

Gasteropores equally distributed on both sides of the branches, never provided with a lip. Diameter 0.3 mm.

Large dactylopores about 0.25 mm. in diameter.

Small dactylopores:—It may be open to discussion whether there is or is not any true dimorphism of the dactylopores in this species. It has been shown that in one of the specimens from New Zealand ("Dendyi") the small dactylopores are provided with shallow collars. In the Cape specimen some of the dactylopores are considerably less in diameter than the majority, but they are provided with exactly the same kind of semicircular ridge as the larger ones. The question of dimorphism, therefore, resolves itself in this case into a question whether the essential feature of the dimorphism of the dactylopores consists in their size or in the presence of a grooved spine. Ridley states that in *Errina* (*Labiopora*) *moseleyi* the dactylopores are of the usual uniform size, and the two kinds can only be distinguished by the presence or absence of nariform processes. These facts seem to emphasize the conclusion that the so-called dimorphism of the dactylopores is not really a feature of very great importance, and to suggest as a probability that the small dactylopores are the shelters for young dactylozooids which in their later stages of growth increase in size and become protected by a grooved spine.

The specimen described and figured by Gray (1872) as *Errina fissurata*, from the Antarctic seas, was apparently very closely related to this species. Unfortunately the specimen has been mislaid (*vide* Moseley) and cannot therefore be re-examined, but the figures show a similar robust habit of growth and short semicircular grooved spines with the grooves all turned away from the apex of the branch.

#### ERRINA (LABIOPORA) ANTARCTICA Gray.

*Porella antarctica* Gray.

*Labiopora antarctica* Moseley.

*Labiopora antarctica* Ridley.

The type-specimen was found off the Falkland Islands, 54° 27' S., 59° 40' W., in 45 fathoms.

A second specimen, attributed to this species by Ridley, was found in Trinidad Channel, S.W. Chili, in 30 fathoms.

Hydrophytum flabellate in growth. There is no statement to the effect that the branches anastomose. No record of size beyond the statement that it is smaller than *L. moseleyi*.

Colour: bright crimson, with the compressed forked tips paler.

Surface minutely reticulate. Grooved spines arranged in rows, but not in clusters, on both sides of the branches, all turned away from the apex of the branch.

Gasteropores without a lip, 0.22 mm. in diameter (in the Chili specimen).

Large dactylopores  $0.09 \times 0.2$  mm.

Small dactylopores 0.08 mm., without any lip or collar.

#### ERRINA (LABIOPORA) MOSELEYI Ridley.

The single specimen of this species was found at Port Rosario, S.W. Chili, 2-10 fathoms.

Hydrophytum flabellate in growth. Anastomoses frequent. 95 mm. in height  $\times$  135 mm. in width.

Colour: "vermilion."

"An anterior clearly distinguishable from a posterior surface, by the development on it of numerous tubercles, chiefly in the terminal branches, which are very slightly indicated in the latter." Surface minutely reticulate. Grooved spines not arranged in definite rows nor in clusters.

Gasteropores without any lip, 0.32 to 0.35 mm. in diameter.

Large dactylopores 0.1 to 0.14 mm. in longitudinal diameter.

Small dactylopores without lips or tubercles, of about the same size as the large dactylopores.

#### ERRINA (LABIOPORA) ASPERA Linn. (Pl. XCV. fig. 6.)

I have examined the type-specimen of this species in the British Museum on which Gray (1) founded the genus *Errina*. There can be no doubt that the affinities of the species with the genotype of *Labiopora* are closer than they are with Moseley's *Errina labiata*. It belongs to the *Labiopora*, and not to the *Errina* group of species.

One of the colonies in the British Museum is 80 mm. in height by 85 mm. in width. It forms a flabellum with a clear difference between the anterior and posterior surfaces. The branches terminate in fine points and do not anastomose. The branches are about 3 mm. in diameter at a distance of 3 mm. from the apices. The surface is minutely granular. The grooved spines sometimes occur in clusters, but when solitary the grooves are turned away from the apex of the branch. There are a few small dactylopores without spines and some with small or rudimentary spines. This specimen was dredged off the coast of Sicily.

A little while ago a specimen of a Stylasterine coral was sent to me by the late Mr. John Morgan of Worthing. It was purchased in a sale and there was no record of its locality.

At first I thought it should be placed with the other specimens



in my collection in the species *Errina* (*L.*) *novae zelandiae*, but, on comparing it with the specimens in the British Museum, I came to the conclusion that it is probably related more closely to *Errina* (*L.*) *aspera*. It is moderately branched and roughly flabelliform in growth. The terminal branches are fairly thick, being about 2-2.25 mm. at a distance of 3 mm. from the apex. The branches do not anastomose.

The surface and substance of the cœnosteum are minutely granular.

The grooved spines are very crowded and clustered on the terminal branches, and not arranged in rows (fig. 6). The grooves are turned in all directions, but the majority of them away from the apex of the branch.

The gasteropores are equally distributed on both sides of the flabellum, and are without any lip or collar. Size 0.13-0.17 mm. in diameter.

The large dactylopores are very variable in size,  $.09 \times .09$  mm. to  $.06 \times 0.11$  mm.

The small dactylopores are very numerous, 0.06 mm. in diameter, and provided with small curved lips.

The specimen is like the type in being white in colour.

Mr. Morgan's specimen differs from the type in having rather more slender branches, in having the pores equally distributed on the two surfaces of the flabellum, and in the presence of numerous small dactylopores.

#### *ERRINA* (*LABIOPORA*) *GRACILIS* von Marenzeller.

Several specimens of this species were found by the 'Belgica' Expedition attached to the swabs when dredging off the pack ice in the region of 71° S. and 88° W., *i. e.* about 20 degrees west and 15 degrees south of the Straits of Magellan. The depth is not recorded by von Marenzeller, but it is probably between 500 and 600 metres.

The hydrophytum is flabellate in growth, with well-marked anterior and posterior surfaces. One of the specimens, which proved to be a female, was 25 mm. in height and 30 mm. in width. Another, which proved to be a male, was 100 mm. by 140 mm.

The surface of the cœnosteum is finely wrinkled, and marked with transverse and longitudinal ridges (*Kammschen*). There are apparently no well-marked cœnosteal pores.

Grooved spines not arranged in definite rows, but in irregular clusters or singly. The grooves of the grooved spines turned away from the apex of the branches or sideways.

Gasteropores with a lip, .015 mm. in width.

Large dactylopores sheltered by spinous projections provided with a deep groove.

Small dactylopores with or without a lip.

Colour: white or brownish.

There can be little doubt that this species belongs to the

*Labiopora* group. It is true that the description given by von Marenzeller of the surface of the cœnosteum does not agree with that of the other species of the group, but it does not agree either with the description given of the surface of the cœnosteum of the *Errina* group. The absence of well-defined cœnosteal pores, the grouping of some of the grooved spines in clusters, and the direction of their grooves—all point to the affinities of the species with the *Labiopora* group.

It may be remarked that this is the only species of the group that occurs in deep water.

*Review of the Labiopora Group of Species.*

The careful examination of the specimens belonging to the *Labiopora* group leads me to the conclusion that there are very few characters that can be used with much confidence for the separation of species \*. However, it may be convenient for the present to recognise six species :—

*Errina (Labiopora) aspera* Linn. Mediterranean Sea.

*Errina (Labiopora) antarctica* Gray. Chili and Falkland Islands.  
30 to 45 fathoms.

*Errina (Labiopora) moseleyi* Ridley. Chili. Shallow water.

*Errina (Labiopora) novæ zelandiæ* Hickson. New Zealand.  
Shallow water.

*Errina (Labiopora) capensis* Hickson. Cape of Good Hope.  
30 fathoms.

*Errina (Labiopora) gracilis* von Marenzeller. Antarctic Sea.  
Deep water.

Of these six species *Errina (Labiopora) capensis* appears to be the most sharply defined. It probably attains to a much larger size, has more robust branches terminating in blunt and somewhat flattened extremities. Its substance is coarsely reticular and its surface coarsely granular. The grooved spines are short and semicircular in shape. All the dactylopores are guarded by these spines.

The other five species are very closely related. *Errina (L.) antarctica* appears to be distinguished from the others by the grooved spines being arranged in definite rows, and *Errina (L.) moseleyi* by the differentiation of an anterior from a posterior surface of the flabellum. Of *Errina (L.) novæ zelandiæ* all that can be said is that it appears to be a very variable species which does not exhibit any one particular distinguishing feature. *Errina (L.) gracilis* is distinguished from the others by the texture of the surface of the cœnosteum, and the colour is not red but white or brownish. *Errina (L.) aspera* has a close resemblance to some of the facies of *Errina (L.) novæ zelandiæ*, but it is always white in colour, in this respect resembling the facies "Cooki."

\* See Note, p. 894.

*General Remarks on Structure.*

*Gasteropores*.—Before concluding this account of these species I may refer briefly to one or two results of a negative character that I have obtained. It occurred to me that if the specimens I examined belonged to different species, there might be some measurable difference to be observed in the styles of the gasteropores. The style is in all cases like an elongated and sharply pointed brush, but careful and constantly repeated comparisons of the styles of the gasteropores of different specimens revealed no characters by which they could be distinguished. The type of style is the same in all the specimens, and although the brush is more slender in some cases than in others, there is a greater range of variation in this respect in the gasteropores of a single specimen than there is in the gasteropores of different specimens taken at random (Pl. XCVI. figs. 14 & 15).

The way in which it is possible to study the shape of the gasteropore styles is to make a vertical fracture in a plane parallel with the long axis of a branch. In a large percentage of such fractures the whole length of at least one gasteropore with its style will be exposed.

In such fractures it may be observed that some of the gasteropores extend as far down as the axis of the branch, but in others they extend only a short distance below the surface. In the long gasteropores the style can be traced right down to the base of the pore, but it is usually supported by one or, in some rare cases, more than one, tabula (fig. 14) similar to the tabulæ described by Miss England (5) in the gasteropores of *Spinipora*. In the short gasteropores the style ends abruptly at the base of the pore and is not supported by a tabula (fig. 15).

In order to make any scientific use of this character in the classification of the species it would be necessary to make a large number of fractures, and for that purpose I have not sufficient material.

The results I have obtained on the few fractures I have made are as follows:—

In *Errina* (*L.*) *novæ zelandiæ* facies “*Ramosa*” and facies “*Cooki*” the gasteropores (I have observed) are long and exhibit a tabula. In the same species facies “*Benhami*” the gasteropores are short, and the same is the case in the facies “*Dendyi*.” In Mr. Morgan’s specimen of *Errina* (*L.*) *aspera* the gasteropore is also short. In *Errina* (*L.*) *capensis* the gasteropores are short, extending only a little way beneath the surface. As to this character in the gasteropores of the other species I have no evidence to bring forward.

My conclusions, from this evidence, are that the length of the gasteropores and the presence or absence of a tabula are not, at present, characters of any value for purposes of classification.

*Gonophores*.—All the specimens I have examined show ampullæ. They can usually be seen on the terminal branches as shallow

convexities on the surface, sometimes between the spines, sometimes carrying the spines with them. They appear to be always absent in the older branches and stems. Our knowledge is still so very imperfect concerning the growth and relations of the gonophores in the Stylasterina that it is not reasonable to use any differences that may be observed in the characters of the ampullæ for purposes of classification.

The questions to be answered are the following :—

1. Are there any constant differences between the male and the female ampullæ?
2. Is there any correlation between the sex of the colonies and characters of the general structure of the cœnosteum?

These two questions could be answered without much difficulty by the examination of a number of preserved specimens of the same species from the same locality.

In Professor Benham's notes on the structure of a specimen which probably corresponds with *Errina (Labiopora) novæ zelandiæ* facies "Ramosa," I find the following remark:—"Each ampulla seems to have a small pore (? dactylopore) on its surface." In the specimen I have examined of this species I cannot find these small pores on the ampullæ. Von Marenzeller also remarks that the male ampullæ exhibit small dactylopores "in niedrigen Spitzchen."

In a previous paper (3) I have shown that, in the ripe male gonophores of *Distichopora* and *Allopora*, the spermatozoa are discharged by a spout-like seminal duct. In the case of the female gonophore, however, the only way of escape of the embryo is by the rupture of the whole surface of the ampulla. It seems possible, therefore, that the pore on the ampulla mentioned by Professor Benham may be for the opening of the seminal duct and that the specimen may be a male. On the other hand, it must not be assumed that when the surface of a specimen is marked by large shallow depressions having the size and appearance of ruptured ampullæ, the specimen is necessarily a female colony, because in the specimen of *Errina (Labiopora) capensis* in which these shallow depressions are very well-marked I found to my surprise that it was a male colony.

As regards the structure of the gonophores there is very little to be said at present. The male gonophores of *Errina (Labiopora) capensis* exhibit a well-developed spadix (manubrium), and in this respect the genus seems to resemble *Distichopora* and to differ from *Allopora*. The only other spirit specimen I have received was a small branch of *Errina (Labiopora) novæ zelandiæ* facies "Benhami," and this proved to be a female. The specimen was not, however, in sufficiently good condition to enable me to study the structure of the gonophore.

*Cœnenchymal Canals*.—From the two spirit specimens I have ascertained certain isolated facts which may be of some use when our knowledge of the genus is extended.

According to Ridley the coenenchymal canals of *L. moseleyi* and *L. antarctica* are 0.035 to 0.07 mm. in diameter, the meshes between the canals are about the same diameter in *L. moseleyi*, but in *L. antarctica* they vary from the same diameter up to 0.14 mm. Ridley does not state how his measurements were obtained, consequently the results I have obtained cannot be compared with his results with any degree of precision.

I have measured the diameter of a number of canals that have been cut transversely in my sections at a level corresponding with the base of the dactylozooids, and I find that the average diameter of these canals is in *Errina (Labiopora) novæ zelandiæ* 0.03 mm. and in *Errina (L.) capensis* 0.05 mm. As the specimens must have undergone very considerable contraction during decalcification and imbedding, I have regarded the measurements of the meshes as worthless. All that can be said is that in both species the meshwork of canals is close and elaborate.

In the 'Challenger' monograph Moseley gives as a character of the genus *Errina* that the number of tentacles on the gastrozooids is four. In the Siboga species of *Errina* the number of tentacles varied from four to five.

In *Errina (Labiopora) novæ zelandiæ* I have found some difficulty in counting the number of tentacles, but judging from a single series of sections, there are not more than four. In the specimen of *Errina (Labiopora) capensis*, however, a very large number of gastrozooids can be clearly seen without decalcification, and in these the number varies from four to six. From this fact it is obvious that the number of tentacles on the gastrozooids cannot be relied upon as a generic or even as a specific character.

#### *List of the Species of the Genus Errina.*

A. Cœnosteum hard and compact, perforated by well-defined cœnosteal pores. Grooved spines turned towards the apex of the branch.

1. With short grooved spines and only one kind of dactylopore.  
The *Errina* group.

*Errina labiata* Moseley.

*Errina ramosa* Hickson & England.

*Errina horrida* Hickson & England.

*Errina carinata* Pourtales?

*Errina pourtalesii* Dall?

\* *Errina glabra* (= *Lepidopora glabra* Pourtales).

\* *Errina cochleata* (= *Lepidopora cochleata* Pourtales).

\* *Errina dabneyi* (= *Lepidopora dabneyi* Pourtales).

2. With long grooved spines and two kinds of dactylopores.

*Errina echinata* (= *Spinipora echinata* Moseley).

- B. Cœnosteum granular and reticulate, without well-defined cœnosteal pores. Grooved spines turned away from the apex of the branches or clustered and irregularly placed.

The *Labiopora* group.

*Errina aspera* Linn.

*Errina fissurata* Gray.

*Errina antarctica* (= *Labiopora antarctica* Gray).

*Errina moseleyi* (= *Labiopora moseleyi* Ridley).

*Errina novæ zelandiæ* Hickson.

*Errina capensis* Hickson.

*Errina gracilis* von Marenzeller.

The following species has the grooves turned away from the apex as in the *Labiopora* group, but has well defined cœnosteal pores:—

*Errina macrogastra* von Marenzeller (?).

[Additional notes on Professor Hickson's paper on the genus *Errina*, received August 14th, 1912.

1. The adjective "Hydrocoralline" is used in the title of the paper at the suggestion of the Secretary of the Society for the convenience of Zoologists who do not possess a special knowledge of these Cœlenterata. I have in several previous papers declared my opinion that to unite Millepora with the Stylasterina in one Order, the Hydrocorallina, is unsound. I have found no reason to change my mind in that respect. The word "hydrocoralline" may still be used, however, to signify the corals that are Hydrozoa in very much the same way as the words "corals," "zoophytes," "worms," are used, without any strict systematic significance.

2. Since the paper was read I have been able to examine a number of specimens in the possession of the Muséum d'Histoire Naturelle, Paris, for which I am indebted to the kindness of Prof. Joubin.

In this collection there are some specimens which I have identified as *Errina dabneyi* Pourt. from the Azores. An examination of these specimens convinced me that they belong to the *Labiopora* group of species, as they exhibit all the characteristic features of that group. From this it seems probable that the other two species, *E. glabra* and *E. cochleata*, that were included by Pourtales in the genus *Lepidopora* should also be transferred from the *Errina* to the *Labiopora* group.]

#### Literature.

- (1) J. E. GRAY.—(No title.) Proc. Zool. Soc. 1835, p. 85.
- (2) J. E. GRAY.—Notes on Corals from the South and Antarctic Seas. Proc. Zool. Soc. 1872, p. 744.
- (3) S. J. HICKSON.—The Gonophores of *Allopora* and *Distichopora*. Quart. Journ. Microscop. Sci. vol. xxxii. 1891, p. 382.

- (4) S. J. HICKSON & HELEN M. ENGLAND.—The *Stylasterina* of the Indian Ocean. Trans. Linn. Soc. xii., 1909.
- (5) S. J. HICKSON & HELEN M. ENGLAND.—The *Stylasterina* of the Siboga Expedition. 1905.
- (6) E. VON MARENZELLER.—Madreporaria and Hydrocorallia. Résultats du Voyage du S.Y. 'Belgica.' 1903.
- (7) E. VON MARENZELLER.—Stein- und Hydro-Korallen. Bull. Mus. Comp. Zool. xliii. 2. 1904.
- (8) H. N. MOSELEY.—Zoological Collections of H.M.S. 'Challenger,' vol. ii. 1881, p. 50 *seq.*
- (9) L. F. DE POURTALES.—Deep Sea Corals. Illustrated Catalogue Museum Comp. Zoology, Harvard, 1871.
- (10) S. O. RIDLEY.—Zoological Collections of H.M.S. 'Alert.' Proc. Zool. Soc. 1881, p. 105.

## EXPLANATION OF THE PLATES.

## PLATE XCIV.

- Fig. 1. *Errina (Labiopora) novæ zelandiæ* (facies Benhami); a portion of a branch showing the grooved spines arranged in clusters or with the grooves turned away from the apex.  $\times 4\frac{1}{2}$  diam.
- Fig. 2. Another photograph of the same facies (Benhami) showing a number of closely packed anastomosing branches. In this view it will be seen that although the greater number of the grooves are turned away from the apex of the branches (the top of the photograph), in places where they are clustered they are turned in all directions.  $\times 4\frac{7}{8}$  diam.
- Fig. 3. The same species (facies Ramosa). The grooved spines are not so crowded and rarely form clusters. Nearly all the grooves are turned away from the apex.  $\times 9\frac{1}{2}$  diam.
- Fig. 4. The same species (facies Dendyi). The grooved spines are still more scattered and nearly all the grooves are turned away from the apex. In this photograph several gasteropores can be seen.  $\times 9\frac{1}{2}$  diam.

## PLATE XCV.

- Fig. 5. *Errina (Labiopora) novæ zelandiæ* (facies Cooki.) In this facies many of the spines are in clusters, consequently the grooves appear to be turned in all directions.  $\times 4\frac{1}{2}$  diam.
- Fig. 6. *Errina (Labiopora) aspera*. In this specimen the spines are rather water-worn, but frequently occur in clusters and the grooves point in all directions.  $\times 4\frac{1}{2}$  diam.
- Fig. 7. *Errina (Labiopora) capensis*. The spines are very short and the grooves all point away from the apex. In this photograph the style can be seen in many of the gasteropores.  $\times 4\frac{1}{2}$  diam.
- Fig. 8. *Errina (Spinipora) echinata*. In this species, as in the *Errina* group of species, the grooves are turned towards the apex.  $\times 4\frac{1}{2}$  diam.

## PLATE XCVI.

- Fig. 9. *Errina (Labiopora) novæ zelandiæ* (facies Ramosa). Slightly enlarged, showing the profuse ramification without anastomoses, and branches terminating in delicate points. Drawn by Prof. Benham.
- Fig. 10. *Errina (Labiopora) novæ zelandiæ* (facies Cooki). Slightly enlarged, showing the method of ramification and branches terminating in blunt points. Drawn by Prof. Benham.
- Fig. 11. A terminal branch of the same species (facies Cooki), showing the dactylopores (D) protected by the grooved spines and the gasteropores (G).  $\times 6$  diam. Drawn by Prof. Benham.
- Fig. 12. A portion of a larger branch of the same species (facies Cooki), showing the grooved spines in clusters.  $\times$  ca. 6 diam. Drawn by Prof. Benham.

- Fig. 13. *Errina (Labiopora) novæ zelandiæ* (facies Benhami). One of the clusters of four grooved spines as seen from above.  $\times$  ca. 12 diam.
- Figs. 14 & 15. These two drawings are intended to show the difference in texture between *Errina (L.) novæ zelandiæ* (fig. 14) and *Errina (L.) capensis* (fig. 15), as seen in vertical section of the cœnosteum. Another point of difference between the two specimens is that in the former (fig. 14) the gasteropore penetrates into the depths of the branch and shows a tabula (*t*) in its course; whereas in the latter (fig. 15) the gasteropore ends abruptly a little way below the surface. This difference, however, cannot be regarded as a specific distinction. G, gasteropore; D, dactylopore; St., style. Both figures  $\times$  35 diam.

54. Descriptions of new Butterflies of the Genus *Thecla* from S.E. Brazil. By E. DUKINFELD JONES, F.Z.S., F.E.S.

[Received May 13, 1912: Read October 29, 1912.]

(Plate XCVII.\*)

INDEX.

Systematic :	Pages
<i>Thecla</i> , 13 new species of .....	896-902

The species described in the present paper were captured by myself and the types are in my own collection.

*THECLA HAMILA*, sp. n. (Pl. XCVII. fig. 1.)

Allied to *T. gispa* Hew.

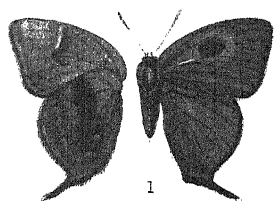
*Male*. Upper side rich purplish blue; costa and termen of fore wings narrowly black, wider at apex; base of costa greenish; a large black silky spot with blue reflection beyond cell; cilia black. Hind wings: costa and termen narrowly black; inner margin greyish black, rather broad at tornus; tails black with white tips; a few white scales on inner side of lobe; some greyish green at tornus above the black margin; submedian hairs greenish blue; head black; thorax greenish blue; abdomen purplish blue. Under side dull stone-green suffused with black, a pale green reflection over all. Fore wings: a medial row of diffused light stone-green spots from costa to vein 2, the spot above vein 3 distal; an indistinct subterminal diffused pale green band; termen black; cilia black with pale green band at apex. Hind wings darker; a broad diffused black medial shade, very dark below costa; a narrow dark postmedial shade and broad subterminal shade; a medial series of green spots between the veins from inner margin to vein 5, those above veins 2 and 3 distal; termen and cilia black.

Expanse 34 mm.

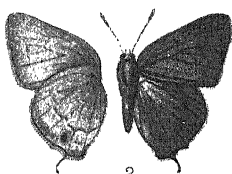
*Hab.* Castro, Paraná, Brazil.

\* For explanation of the Plate see p. 902.

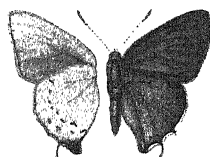




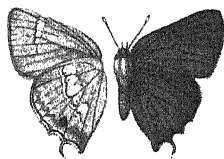
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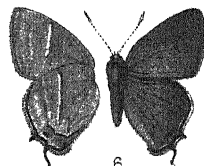
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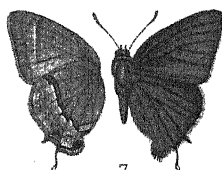
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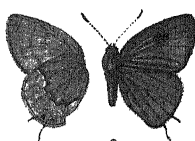
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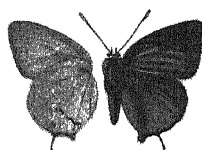
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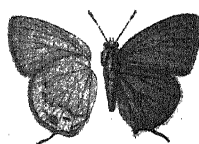
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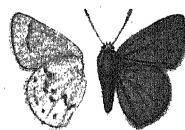
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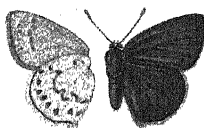
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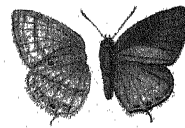
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14



15

Horace Knight del. et lith.

West, Newman del.

NEW SPECIES OF THECLA FROM S. E. BRAZIL.



*THECLA FANCIA*, sp. n. (Pl. XCVII. fig. 2.)

Allied to *T. punctum* H.-S.

*Male*. Upper side bright metallic blue with a greenish reflection on basal half of wings; costa of fore wings narrowly, apex and termen broadly black; a brown circular brand on upper angle of cell; hind wings outwardly broadly black; tails tipped with white. Under side yellowish grey: fore wings, a postmedial band of indistinct brown lunular spots outwardly bordered with white from costa to vein 2; hind wings: postmedial band inwardly dark brown, outwardly white, angled on veins 1 and 2, inwardly oblique from 3 to 4, placed more distally from 4 to 6 and above 7; a small orange spot at tornus and a larger one between veins 2 and 3.

Expanse 30 mm.

*Hab.* Castro, Paraná, Brazil.

*THECLA SICRANA*, sp. n. (Pl. XCVII. fig. 3.)

*Male*. Upper side dull metallic blue; costa and termen of fore wings narrowly black; submedian hairs on hind wings greyish; tornus dull orange; tails and cilia black tipped with white. Under side bright green; inner margin of fore wings bluish grey; hind wings: an indistinct postmedial series of lunular spots inwardly black, outwardly white; dark red-brown subterminal spots above veins 1, 2, and 3, the one above 2 larger; tornus dark red-brown; cilia black tipped with white. Palpi white with some lateral tawny scales, 3rd joint black; frons brown, with a few metallic green scales; a white point between antennæ; abdomen bluish grey above, white beneath.

Expanse 30 mm.

*Hab.* Castro, Paraná, Brazil.

*THECLA BERTHA*, sp. n. (Pl. XCVII. fig. 4.)

*Female*. Upper side smoky brown, inwardly suffused with bluish grey; fore wings irrorated from median nervure to inner margin with light blue; cilia smoky brown interrupted by white between the veins; in the hind wings the irroration covers the cell also; tornus tawny, with a dark spot on lobe; tails black with white tip; cilia outwardly whitish. Under side bright green; basal half of submedian area of fore wings brownish grey, outer half light grey; a rather broad clear white postmedial band with indistinct dark central line from costa to vein 2; cilia reddish brown, tipped with white between the veins. Hind wings: a nearly straight white medial line defined by maroon on both sides from vein 8 to vein 1, angled inwards at origin of veins 3 and 4, broken at vein 2, being placed more distally below the vein, angled inwardly on submedian fold; a large white spot slightly irrorated with maroon above upper angle of cell; three spots in cell; one spot above vein 2 and one above vein 1; a terminal series of lunular maroon spots irrorated with white, fusing at the veins, the one above vein 2 being produced inwardly,

forming a large maroon spot without irroration; cilia reddish brown, tipped with white between the veins.

Expanse 30 mm.

*Hab.* Castro, Paraná, Brazil.

*THECLA SCHAUSA*, sp. n. (Pl. XCVII. fig. 5.)

*Male.* Upper side: fore wings black; cell and submedian area to near tornus metallic purplish blue; extreme edge of costa tawny; a small dark grey band beyond cell; cilia grey; hind wings metallic purplish blue; costa and apex black; termen narrowly black; tornus tawny red; cilia grey. Under side: fore wings brown; a purplish reflection on medial area below costa; a postmedial wavy dark red line from costa to vein 2; a terminal band of dark red irrorations wide at apex and tapering down to vein 2; termen tawny red; hind wings purplish brown; an inner and a medial line of red irrorations; outer half of wing somewhat greyish, very thickly irrorated with red; a diffused red subterminal band; termen tawny red. Frons tawny red; palpi white mixed with brown; pectus white.

*Female.* Very similar to the male; the blue of the wings is duller; cilia almost white; termen of hind wings more broadly black.

Expanse, male 17 mm., female 17 mm.

*Hab.* Castro, Paraná; São Paulo, S.E. Brazil.

*THECLA JAPOLA*, sp. n. (Pl. XCVII. fig. 6.)

Allied to *T. gaina* Hew.

*Female.* Upper side dull steel-blue; costa, apex, and terminal area of fore wings broadly greyish black; a dark diffused spot beyond cell; basal half of extreme costa tawny; cilia outwardly brown. Hind wings: costal and terminal areas greyish black, lighter than fore wings; an indistinct subterminal row of dark lunular spots, conspicuous above veins 1 and 2; a red spot on lobe; tails black, tipped with white; termen black, preceded by whitish line; cilia black at base, white at centre, brown at tips. Under side brownish grey; fore wings: an inwardly diffused reddish-brown postmedial band, outwardly white, straight from costa to vein 2; terminal area pale grey with two diffused brown bands, the inner broad, the outer narrow; termen dark brown; cilia light brown; hind wings: an inwardly reddish-brown, outwardly white medial band straight from costa to vein 2, angled on veins 1 and 2 forming a very acute W; terminal area whitish grey with an inner brown band, broad and diffused at costa, narrow and distinct at tornus, bent strongly towards base on inner margin, followed at tornus by orange-red to a black spot on lobe, some white at base of lobe; an orange-red lunular spot with black point above vein 2; termen dark brown; cilia lighter with pale band.

Expanse 28 mm.

*Hab.* Castro, Paraná, Brazil.

*THECLA FERNANDA*, sp. n. (Pl. XCVII. fig. 7.)

Allied to *T. nubilum* H. H. Druce.

*Male*. Upper side dark blackish brown; a red spot on lobe and a few white scales at tornus; tails black tipped with white. Under side yellowish grey-brown; fore wings: a dark postmedial band outwardly bordered with white, nearly straight from costa to vein 2; hind wings: postmedial band inwardly shaded with red and outwardly with white, angled on veins 1 and 2, proximate between veins 3 and 4, straight from 4 to 7, distal above 7 forming conspicuous spot at costa. Differs from *T. nubilum* in the band on fore wing being straighter, that on the hind wing less acutely angled on veins 1 and 2 and in the distal spot at costa, also in absence of discocellular bar.

Expanse 29 mm.

*Hab.* Fernandes Pinheiro, Paraná, Brazil.

*THECLA NORA*, sp. n. (Pl. XCVII. fig. 8.)

*Male*. Upper side dark metallic lilacine blue; costa and termen of fore wings narrowly black, broader at apex; a large black brand beyond cell; cilia black at base, whitish metallic blue at tips; hind wings: costal area greyish brown; a fine black terminal line; cilia black with bluish-white band. Under side brownish grey: fore wings suffused with steel-blue on submedian area; postmedial band inwardly dark brown, outwardly white from costa to vein 3, below vein 3 the brown changes to blue; a very indistinct subterminal line, inwardly white, outwardly brown; cilia brown; hind wings: postmedial band dark brown, shaded inwardly with orange and outwardly with white, strongly angled on veins 1 and 2, outwardly displaced between 4 and 5; a series of subterminal lunular spots shaded inwardly with white, followed by orange spot at tornus, a dark spot irrorated with white below vein 2 and an orange spot containing black point below 3; a narrow white terminal line; cilia dark brown with bluish-white tips.

Expanse 24 mm.

*Hab.* Castro, Paraná, Brazil.

*THECLA MOLENA*, sp. n. (Pl. XCVII. fig. 9.)

Closely allied to *T. lemona* Hew.

*Male*. Upper side dull dark metallic blue; fore wings: outer half of costa, apex and termen black; a large oval black brand, crossed by blue discocellular bar; extreme costa tawny at base; hind wings: termen narrowly black; tails black tipped with white; a red spot on lobe. Under side brown with a lilacine reflection on terminal area of fore wings and the whole of the hind wings. The bands and lines are much the same as in *T. lemona*, but they are much more diffused and subdued; this difference and the lilacine reflection readily distinguish the species. *T. lemona* is also a larger insect than the present.

*Female.* Upper side brown, suffused with lilacine on basal area. Under side as in male, but the lilacine reflection is much less pronounced.

Expanse, male 24 mm., female 24 mm.

*Hab.* Castro, Paraná, Brazil.

*THECLA ESMERALDA*, sp. n. (Pl. XCVII. figs. 10, 11.)

Close to *T. janias* Cr., but differs in the very much wider black margins of the upper side and in the postmedial line, and in the orange spot in place of the black spot on the under side in *janias*.

*Male.* Palpi and head vivid metallic green; legs green; tarsi inwardly whitish and banded with black; thorax, abdomen, and wings rich purplish blue. Fore wings broadly bordered with black on costa and termen, very broad at apex; a small circular dark grey brand. Hind wings broadly black on costal and apical areas, narrowly from vein 4 to tornus; a green spot on the black at tornus; tails black tipped with white. Under side: fore wings vivid metallic green, inner margin grey; cilia brown: hind wings vivid metallic green; a fine black wavy postmedial line, most distinct at inner margin; some lunular subterminal spots near tornus, that above vein 2 being bright orange; some white scales at tornus.

*Female.* Thorax green; wings and abdomen brown, with slight lilacine grey tint on hind wings and basal half of fore wings. Under side as in male, but the postmedial line clearer and the orange spot above vein 2 much larger, there is also some orange at tornus; cilia inwardly black, outwardly whitish.

Expanse, male 27 mm., female 25 mm.

*Hab.* Castro, Paraná, Brazil.

*THECLA CASTRENA*, sp. n. (Pl. XCVII. figs. 12, 13.)

Allied to *T. phrosine* H. H. Druce.

*Male.* Upper side dark blackish brown; a few lilacine scales at base and along inner margin of fore wings; a slight lilacine reflection on hind wings; termen dark and cilia white in both wings. Under side: fore wings pale lilacine blue; apex and inner margin whitish; a lilacine reflection over the whole; a medial V-shaped mark on submedian fold; a slightly wavy red-brown postmedial band from costa to vein 2, followed by white spot above vein 6; a fine black terminal line, becoming brown at apex; cilia white at tornus, shading to brownish at apex. Hind wings white with lilacine reflection; a bright orange-tawny irregular postmedial band of elongated spots, placed distally below veins 1, 3, 5, 6 and 8, and proximally below 2, 4 and 7; a sub-terminal row of minute tawny and black spots between the veins; a fine black terminal line, shading to brown at tornus; cilia white.

*Female.* Upper side the same as the male, except that the cilia

are brown. Under side yellowish grey, the hind wings lighter than fore wings; bands as in male, but the postmedial is outwardly shaded with white and there is a subterminal series of red spots from vein 2 to 6; termen brown; cilia brown: on the hind wing the subterminal spots are much larger than in the male, termen brown, inwardly shaded with white, cilia greyish white.

Expanse, male 25 mm., female 24 mm.

*Hab.* Castro, Paraná, Brazil.

*THECLA CAMPA*, sp. n. (Pl. XCVII. fig. 14.)

Near *T. biblia* Hew.

*Male.* Upper side dull blackish blue, shading to black on outer half of fore wings; cilia brown; hind wings; termen narrowly black; fringe of abdominal fold white; cilia black, with white band at tornus, outwardly brown at apex. Under side light green with a light lilacine-blue reflection; cilia of fore wings light brown; hind wings: an obscure greyish-white discocellular bar; an obscure sinuous greyish-white postmedial line, more clearly defined from inner margin to vein 3; a black spot at tornus with some white scales above and below it; a minute black point below vein 2 and a small orange-red spot ringed with black below vein 3; termen near tornus bluish white. Palpi white with green reflection, third joint black above, white beneath; frons metallic green; back of head and tegulae dark brown; eyes surrounded with white; body blue-black above, creamy white beneath.

Expanse 22 mm.

*Hab.* Castro, Paraná, Brazil.

*THECLA DATITIA*, sp. n. (Pl. XCVII. fig. 15.)

Very near *T. tadita* Hewitson, but differing from it in the possession of tails, the narrow black margins on upper side of the hind wings, and in the terminal rows of lunular spots and the black spots on the under side of the hind wings.

*Male.* Upper side: fore wings smoky black; a very dark medial suffusion from costa to vein 2; outer two-thirds of cell filled with raised brown scales; a submedian patch of lilacine blue from base to near tornus; termen dark; cilia greyish; hind wings lilacine blue, broadly black on costa and apex; a series of diffused black subterminal spots, confluent below apex; termen dark; cilia greyish; tails dark with white tips. Under side grey with light brown bands. Fore wings: a light brown discocellular bar; a well-defined light brown postmedial band, diffused on inner side; a narrower and wavy subterminal band followed by a row of diffused spots; termen light brown; cilia grey at base, brown at tips. Hind wings: base light brown irrorated with grey; a light brown discocellular bar; a dark narrow postmedial band, diffused on inner side and followed by

narrow grey line and broad light brown suffusion; a medial spot ringed with grey at costa; a terminal series of diffused lunular spots, containing a black spot above vein 2.

Expanse 23 mm.

*Hab.* Fernandes Pinheiro, Paraná, Brazil.

#### EXPLANATION OF PLATE XCVII.

Fig. 1. *Thecla hamila* ♂.

2. " *fancia* ♂.

3. " *sierana* ♂.

4. " *bertha* ♀.

5. " *schansa* ♂.

6. " *japola* ♀.

7. " *fernanda* ♂.

8. " *nora* ♂.

Fig. 9. *Thecla molena* ♂.

10. " *esmeralda* ♂.

11. " " ♀.

12. " *castrina* ♂.

13. " " ♀.

14. " *campa* ♂.

15. " *dulitia* ♂.

#### 55. The Bornean Bantin.

By R. LYDEKKER, F.R.S., F.Z.S.\*

[Received October 1, 1912: Read October 29, 1912.]

(Text-figures 123-125.)

That the Bantin of Borneo should be subspecifically distinct from the typical *Bos sondaicus* of Java is what might naturally be expected, and the only wonder is that its distinction has not long since been recognized and a name assigned to the local race. This, however, is not improbably due to the fact that, so far at least as this country is concerned, the Javan Bantin is an exceedingly rare animal in museums, the only complete adult example in the British Museum (Nat. Hist.) being the mounted skin of a bull obtained by exchange with the Leiden Museum in 1846, and now, as might have been expected after long and unprotected exposure in the galleries at Bloomsbury, in an exceedingly dilapidated condition. The Museum also possesses a fine mounted head of a bull, presented in 1904 by Baron L. T. H. van Heckeren-tot-Walien; and also the skeletons of a bull and cow, with the horns, obtained from Leiden at the same time as the mounted skin, the skull of the former being exhibited in the Pavilion at the further end of the Lower Mammal Gallery. In addition to these is the mounted skin of an immature male, and also a young skull, with horns—from the Lidth de Jende collection—both of which present all the characteristics of the Javan race.

On the other hand, the Museum has a considerable series of skulls and horns of the Bornean Bantin presented by Mr. H. B. Low in 1880 and 1887, as well as two presented by Mr. W. B. Pryer in 1886, all these being from North Borneo. Sir Edmund Loder also possesses at least two frontlets and

\* By permission of the Trustees of the British Museum.

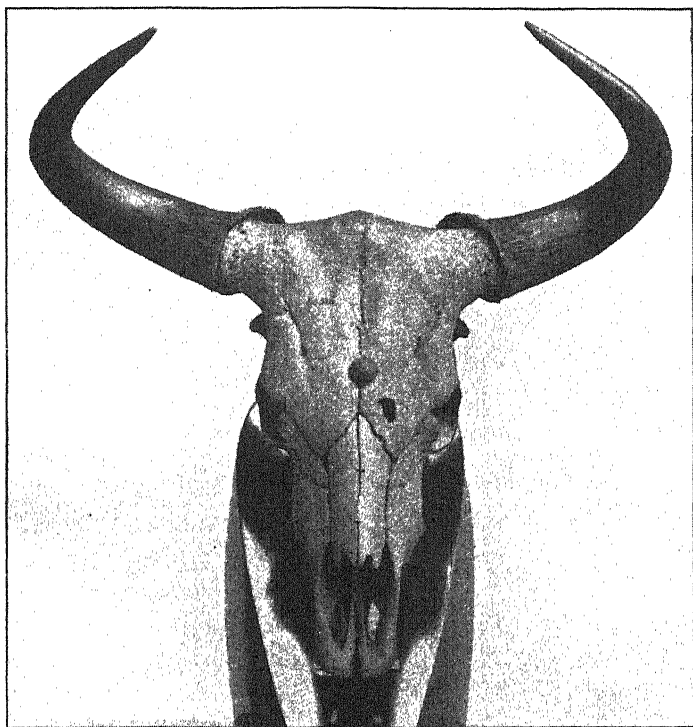


horns of subadult Bornean Bantins in his private museum at Leonardslee.

As regards the colour of the Bornean Bantin I know nothing definite; but, in the absence of any statement to the contrary, I presume it is approximately similar to that of the typical Javan race; that is to say, adult bulls are blackish brown or black with a large white rump-patch and white "stockings," while the cows and young bulls have the dark area rufous or chestnut.

In all the above-mentioned Javan specimens in the Museum the horns are of the type of those shown in text-fig. 123, which

Text-fig. 123.

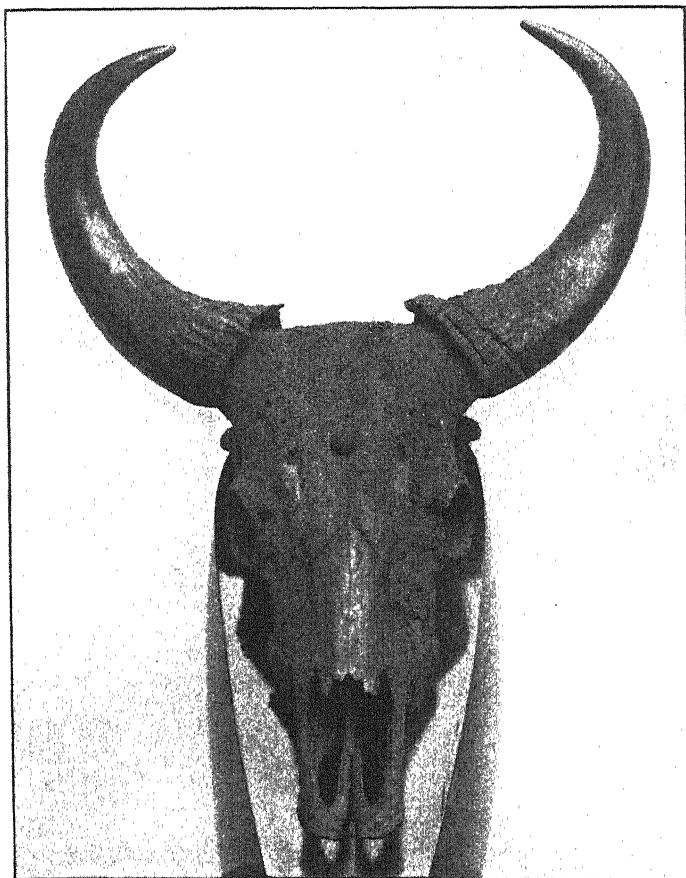


Skull and horns of male Javan Bantin (*Bos sondaicus*) in the British Museum.

represents the skull of a bull obtained from Leiden in 1846. At their origin the horns are directed mainly outwards, but at rather more than half their length they curve suddenly inwards with a somewhat forward and finally a backward inclination. This

causes them to have a relatively large maximum span and a correspondingly small tip-to-tip interval, as is indicated in the table of measurements given below. In consequence, I take it, of the outward and somewhat backward direction of the basal portion of the horns, the frontal region of the skull is somewhat convex, while the intercornual ridge has a distinct prominence in the middle line.

Text-fig. 124.

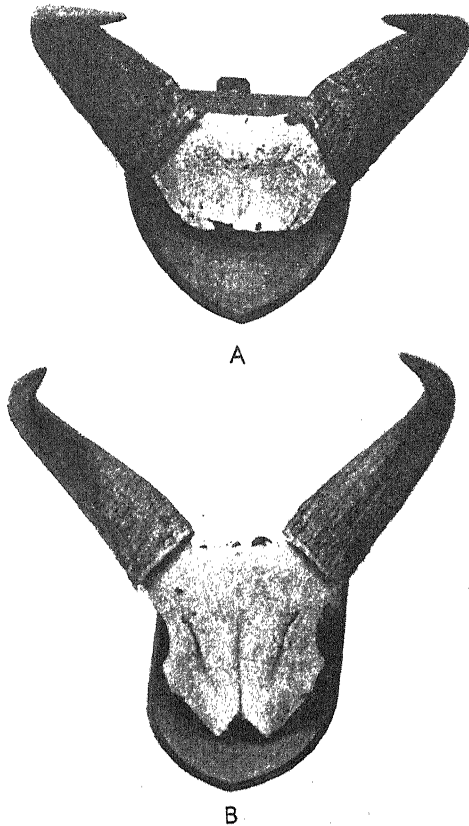


Skull and horns of male Bornean Bantin (*B. sondaicus lowi*), from the Rejang Valley, in the British Museum.

In the Bornean Bantin, as typified by the largest of the skulls presented by Mr. Low to the British Museum (text-fig. 124), the horns, which are relatively stouter, are less curved and have a

more upright direction, arising at an angle of about  $45^{\circ}$  from the ends of the frontal ridge of the skull, and finally curving inwards to a less extent than those of the typical race, the terminal portion thus being shorter and the maximum span less. Similar characters are shown in the two frontlets with horns in the

Text-fig. 125.



A & B.—Frontlets and horns of two Bornean Bantins (*B. sondaicus lowi*) in the collection of Sir E. G. Loder.

collection of Sir E. G. Loder, represented in text-fig. 125, these also exhibiting the relatively small size of the horns which appears to characterise many Bornean Bantin heads. The skull of the Bornean Bantin is characterised by the flatness of the forehead and the straight intercornual ridge.

The dimensions, in inches, of the specimens represented in text-figs. 123 & 124 are as follows :—

	<i>B. sondaicus.</i>	<i>B. s. lowi.</i>
Length of horn on outer curve .....	25	21½
Basal girth of ditto .....	11½	12½
Maximum span of horns .....	28	23½
Tip-to-tip interval of ditto .....	16	13
Length from intercornual ridge of skull to tip of nasals .....	16	13½
Minimum width of skull between base of horn-core and orbit .....	9	7½

These differences fully justify the right of the Bornean Bantin to racial distinction, and as none of the comparatively few synonyms of *Bos sondaicus* appears referable to that race, I propose that it should be known as *B. sondaicus lowi*; the skull and horns represented in text-fig. 124 (B. M. No. 87.2.10.4) being the type.

It may be added that both the Burmese Bantin or Tsaine, for which I proposed the name of *B. s. birmanicus* in the Society's 'Proceedings' for 1898, p. 277, and the Siamese Bantin, for which I have suggested the name of *B. s. porteri*, Ibid. 1909, p. 669, have horns of the general type of those of the typical race, although those of the Siamese race are more heavily wrinkled at the base than any Javan horns in the British Museum.

Information is still required as to whether the Bantin occurs in Sumatra.

## 56. Notes on the Breeding of the "Millions" Fish (*Girardinus pacciloides*). By EDWARD G. BOULENGER, F.Z.S., Curator of Reptiles.

[Received October 18, 1912: Read October 29, 1912.]

The little fish *Girardinus pacciloides*, popularly known as "Millions" in Barbados on account of the enormous numbers frequenting all the shallow pools in that island, is said to be of great practical value on account of its devouring mosquitoes; the absence of malaria, which is so prevalent in the neighbouring islands, is believed to be due, as first pointed out by Mr. C. Kenrick Gibbons, to the presence of this fish, for the insect conveying the malarial disease breeds only in shallow pools, where these fish abound and, it is well to add, have no competitors, *G. pacciloides* being the only freshwater fish inhabiting Barbados. For this reason, the Society arranged with the Colonial Office to keep a large stock and to supply specimens to various tropical stations in the British Empire. The fishes have bred on numerous occasions in small aquariums in the Reptile and Tortoise Houses,

and I have thus been able to observe certain facts in relation to their breeding habits, to one of which in particular I wish to draw attention, namely that in some cases the male breeds before the assumption of its secondary sexual characters. Before dealing with this matter it is necessary to mention briefly the sexual differences, which are very marked. Females, which may measure up to 25 mm. in length, are simply of a dull olive-grey in colour, usually with a dark patch above the anal fin, while the males, which do not attain quite so large a size, are most conspicuously ornamented with red, blue, violet and yellow, with a dark ocellar spot situated in the middle of the body, in front of or beneath the dorsal fin, and another at the base of the caudal fin, these spots appearing at least fourteen days before the brilliant hues. Males are to be further distinguished from females by the position and prolongation of their anal fin, which is transformed into an intromittent pairing organ.

The male is remarkably active, and is perpetually courting the female, going through all kinds of antics in front of her, and as breeding goes on all through the year, at least in captivity, the latter is in an almost permanently pregnant condition, and within a fortnight of having brought forth a brood (such a period representing the duration of the gestation, at a temperature of over 70°), once more brings a generation into the world. It should be borne in mind, however, that a single impregnation is sufficient for the fertilization of several broods, the embryos of the second and third generations being already in an advanced condition when the first young are born. Each brood comprises from five to as many as twenty-five fish.

The young fishes grow rapidly: about 4 mm. long at birth, they double that length in a fortnight or so, when their sex can be determined by the shape and position of the anal fin; it is not, however, until at least six weeks after birth that the males become adorned with the brilliant colours which characterise the adult, this period again varying according to the temperature of the water.

The first brood, containing a male which bred before the assumption of its secondary sexual characters, was produced on March 11th of this year, and numbered eleven. As is almost invariably the case, a number of weaklings died within a few days of their birth, and eight fish remained at the end of a fortnight, when I found the sexes to be equally divided, which is remarkable, for as a rule females outnumber males by about three to one. On May 7th, six young ones were born of this brood, and at the time none of the males had developed their adult coloration, the only markings distinguishing them from the females being the spots beneath the dorsal fin and at the base of the caudal, and it was in fact not until six days later that one of these acquired its full sexual livery. The others followed suit on May 17th and 18th. These broods were kept at an average temperature of 80°.

In another case, a brood of fourteen fishes, born on June 5th,

and of which only seven survived, two males and five females, reproduced their species on September 29th and 30th, the adult coloration of the males appearing only on October 7th and 16th. When we consider the fact that these fishes, owing to the warmer tanks being already occupied, were kept at the low average temperature of 65°, we must conclude that, like their growth, the period of gestation must have been slow, and that the male undoubtedly bred at least a month before acquiring its full secondary sexual characters.

A parallel case is well known in the male Salmon, which occasionally becomes sexually mature in the parr condition, while the Wrass (*Coris julis*) and the Dragonet (*Callionymus lyra*) have been observed by Mr. E. W. Holt also to become sexually mature prior to having fully developed their adult characters. In the two latter cases, however, the question is one of degree only, the characteristic male livery not being entirely absent, as in *Girardinus*.

## EXHIBITIONS AND NOTICES.

October 29, 1912.

Prof. E. A. MINCHIN, M.A., F.R.S., Vice-President,  
in the Chair.

The SECRETARY read the following report on the Additions that had been made to the Society's Menagerie during the months of May, June, July, August, and September 1912.

### MAY.

The registered additions to the Society's Menagerie during the month of May were 448 in number. Of these, 207 were acquired by presentation, 60 by purchase, 43 were received on deposit, 72 in exchange, and 66 were born in the Gardens.

The number of departures during the same period, by death and removals, was 203.

Amongst the additions special attention may be directed to :—

A large collection of Mammals and Birds from Nepal, including 1 Indian Rhinoceros (*Rhinoceros unicornis*), 1 Kiang (*Equus kiang*), 2 Barasingha Deer (*Cervus duvaucelli*), 2 Sambur Deer (*Cervus aristotelis*), 3 Hog-Deer (*Cervus porcinus*), 2 Monaul Pheasants (*Lophophorus impeyanus*), 2 Cheer Pheasants (*Catreus wallichi*), and 2 Wedge-tailed Fruit-Pigeons (*Sphenocercus sphenurus*); presented on May 21st by H.M. THE KING.

A pair of European Bison (*Bison bonasus*), from Russia, presented by H.G. the Duke of Bedford, K.G., on May 15th.

1 Black Leopard (*Felis pardus*), from Assam, purchased on May 21st.

1 Branded Palm-Civet (*Arctogalidia stigmatica*), from Sarawak, new to the Collection, presented by Granville J. Altman, Esq., F.Z.S., on May 16th.

1 Civet (*Firerra civetta*), from E. Africa, and 2 Egyptian Mongooses (*Mungos ichneumon*), from Zagazig, presented by H.E. Hassun Hasib Pasha on May 21st.

1 Ural Owl (*Syrnium uralense*), from Northern Europe, presented by E. G. B. Meade-Waldo, Esq., V.P.Z.S., on May 8th.

A collection of rare Reptiles from India, received in exchange on May 21st, containing, amongst others, 2 Banded Kachugas (*Kachuga dhongoka*) and 3 Variegated Snakes (*Zamenis fasciolatus*), new to the Collection, and 2 Gharials (*Gavialis gangeticus*).

### JUNE.

The registered additions to the Society's Menagerie during the month of June were 511 in number. Of these 305 were acquired by presentation, 66 by purchase, 50 were received on deposit, 13 in exchange, and 77 were born in the Gardens.

The number of departures during the same period, by death and removals, was 205.

Amongst the additions special attention may be directed to:—

A collection of Malayan Animals presented by the Government of the Federated Malay States and other Donors on June 24th, including 1 Indian Elephant (*Elephas indicus*), 1 Tiger (*Felis tigris*), 1 Clouded Tiger (*Felis nebulosus*), 1 Binturong (*Arctictis binturong*), 2 Argus Pheasants (*Argusianus argus*), 4 Rufous-tailed Fireback Pheasants (*Acomus erythrophthalmus*), and 1 Malayan Peacock-Pheasant (*Polyplectron bicalcaratum*), besides the following, which were all new to the Collection, viz.:—1 Short-tailed Mongoose (*Mungos brachyurus*), 10 Charlton's Tree-Partridges (*Arboricola charltoni*), 1 Water-Cock (*Gallinerea cinerea*), 2 Water-Snakes (*Acrochordus javanicus*), 1 Bowering's Gecko (*Hemidactylus bowringii*), 1 Bridled Gecko (*Hemidactylus frenatus*), and 1 Leschenault's Gecko (*Hemidactylus leschenaultii*).

2 Malayan Tapirs (*Tapirus indicus*) ♂ ♀, from Palembang, Sumatra, received in exchange on June 22nd.

1 Grys-bok (*Nototragus melanotis*) ♂, from Cape Colony, presented by Dr. Louis Péringuey, C.M.Z.S., on June 3rd.

1 Shoebill (*Balcaniceps rex*), from the Sudan, presented by Lt.-Gen. Sir Francis Wingate, G.C.V.O., on June 29th.

2 Ocellated Turkeys (*Meleagris ocellata*), from Central America, deposited on June 24th.

2 Chestnut-bellied Rock-Thrushes (*Petrophila erythrogastra*), from the Himalayas, new to the Collection, received in exchange on June 17th.

2 Brown-backed Robins (*Thamnobia cambaiensis*), from India, new to the Collection, purchased on June 18th.

1 Temminck's Robin (*Erithacus komadori*), from Japan, new to the Collection, presented by Wilfrid Frost, Esq., on June 14th.

2 Grey Thrashers (*Toxostoma cinereum*), from Lower California, new to the Collection, presented by H. D. Astley, Esq., on June 15th.

6 Chilean Siskins (*Chrysomitris uropygialis*), new to the Collection, presented by Arthur C. Macdonald, Esq., on June 26th.

2 Himalayan White-throated Ground-Thrushes (*Geocichla cyano-notus*), bred in the Menagerie.

12 Russell's Vipers (*Vipera russelli*), born in the Menagerie.

#### JULY.

The registered additions to the Society's Menagerie during the month of July were 289 in number. Of these 155 were acquired by presentation, 13 by purchase, 57 were received on deposit, 25 in exchange, and 39 were born in the Gardens.

The number of departures during the same period, by death and removals, was 301.

Amongst the additions special attention may be directed to:—

1 African Buffalo (*Bubalus caffer*) ♂, from the Ishasha River, Uganda, presented by Capt. E. H. Reid on July 29th.

1 Vaal Rhe-bok (*Pelea capreolus*) ♂, from Basutoland, presented by M. H. Bosworth Smith, Esq., on July 6th.

2 Yellow-headed Wagtails (*Motacilla citreola*) and 1 Brown Shrike (*Lanius cristatus*), from India, new to the Collection, presented by W. J. C. Frost, Esq., on July 25th.

1 Changeable Hawk-Eagle (*Spizaetus linnaetus*), from India, new to the Collection, deposited on July 25th.

1 Hemprich's Gull (*Larus hemprichi*), hatched in the Menagerie on July 22nd.

1 Black-and-White Cobra (*Naja melanoleuca*), from Dunkwa, Gold Coast, presented by Dr. H. G. F. Spurrell, F.Z.S., on July 16th.

1 Snake-Fish (*Polypterus senegalus*), from the Upper Nile, presented by the Rev. Archibald Shaw on July 9th.

#### AUGUST.

The registered additions to the Society's Menagerie during the month of August were 226 in number. Of these 74 were acquired by presentation, 40 by purchase, 55 were received on deposit, 9 in exchange, and 48 were born in the Gardens.

The number of departures during the same period, by death and removals, was 285.

Amongst the additions special attention may be directed to:—

1 White-thighed Guereza (*Colobus vellerosus*), from West Africa, presented by Miss Jean Aylwin on August 30th.

1 Roebuck fawn (*Capreolus capreolus*), from Ross-shire, presented by the Earl of Altamont, F.Z.S., on August 1st.

1 Mount Morrison Laughing-Thrush (*Trochalopteron morrisonianum*), from Formosa, new to the Collection, deposited on August 5th.



1 Magpie-Tanager (*Cissopis leveriana*), 3 Australian Crimson Finches (*Neochmia phaeton*), 2 Peale's Parrot-Finches (*Erythrura pealei*), and 6 Douglas Quails (*Lophortyx douglasi*), all bred for the first time in the Menagerie.

1 Matamoras Terrapin (*Chelys fimbriata*), from Brazil, presented by Oswald Allen, Esq., on August 10th.

12 Six-banded Cyprinodonts (*Haplochilus sexfasciatus*), from West Africa, new to the Collection, presented by Dr. H. G. F. Spurrell, F.Z.S., on August 21st.

#### SEPTEMBER.

The registered additions to the Society's Menagerie during the month of September were 227 in number. Of these 59 were acquired by presentation, 18 by purchase, 20 were received on deposit, 24 in exchange, and 106 were born in the Gardens.

The number of departures during the same period, by death and removals, was 247.

Amongst the additions special attention may be directed to:—

4 Pelzeln's Gazelles (*Gazella pelzelni*), presented by Dr. R. E. Drake-Brockman, F.Z.S., on September 26th.

1 Pelzeln's Gazelle (*Gazella pelzelni*), presented by A. Gibbs, Esq., on September 26th.

1 Capybara (*Hydrochaerus hydrochaeris*), presented by Sir Walter Egerton, K.C.M.G., F.Z.S., and J. J. Nunan, Esq., on September 2nd.

1 White-tailed Gnu (*Connochaetes gnu*), presented by the Government of South Africa on September 28th.

1 Kordofan Giraffe (*Giraffa camelopardalis antiquorum*) ♂, presented by Lt.-Gen. Sir Francis Reginald Wingate, G.C.V.O., K.C.M.G., C.B., D.S.O., on September 13th.

1 Brown Tyrant (*Myiarchus tyrannulus*), from Uruguay, new to the Collection, presented by Mrs. E. F. Dickinson on September 3rd.

1 Great Indian Bustard (*Eupodotis edwardsi*), new to the Collection, presented by Sir John Hewitt, K.C.S.I., on September 30th.

2 European Bee-eaters (*Merops apiaster*), received in exchange on September 11th.

2 Snake-headed Fishes (*Ophiocephalus punctatus*), from India, new to the Collection, received in exchange on September 7th.

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#### "GAZELLA HAYI" = GAZELLA FUSCIFRONS.

Mr. R. LYDEKKER, F.R.S., F.Z.S.\*, contributed the following note:—

"As the result of an unfortunate accident, namely the transposition of the registration labels of two gazelles received simultaneously at the British Museum, I find that I have described and figured a specimen of the Seistan *Gazella fuscifrons*

\* By permission of the Trustees of the British Museum.

as a new African species under the name *G. hayi* (Proc. Zool. Soc. 1911, p. 961, text-fig. 193 A). My apologies are due both to the Society and to naturalists in general for this most unfortunate mistake.

The text-figure of the so-called *G. hayi* will serve as an illustration of the male of *G. fuscifrons*. The gazelle collected by Mr. Hay in Algeria is, I believe, *G. isabella*."

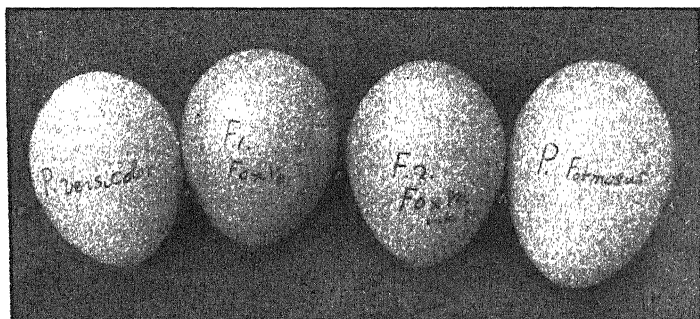
The Rev. T. R. R. STEBBING, M.A., F.R.S., F.Z.S., communicated a memoir on the Crustacea Isopoda collected by the 'Porcupine' Expedition in 1869-1870, in which he described one new family, two new genera, and four new species.

This memoir will be published in the 'Transactions' in due course.

Mrs. ROSE HAIG THOMAS, F.Z.S., exhibited the eggs of *Phasianus formosanus*, *P. versicolor*, and their F. 1 and F. 2 offspring, and made the following remarks:—

"Last February I exhibited to the Society a series of Pheasant skins of an experimental cross between a Formosan female and a *versicolor* male, illustrating the transmission by the male parent to his female offspring of most of the female characters of his

Text-fig. 126.



Eggs of *P. versicolor*, F. 1, Fo.×Ve., F. 2, Fo.×Ve.×Ve., and *P. formosanus*.

race: further evidence of this is now exhibited, namely, the eggs of the two parent species and those of their F. 1 and F. 2 offspring. It is plain that a considerable difference in dimensions exists between the eggs of *P. formosanus*, the larger, and *P. versicolor* the smaller of the two: the expectation was that the eggs of the offspring would resemble in size the egg of the female parent species rather than that of the male parent species; but, on comparing them, it is clear that the eggs of F. 1 and F. 2 are simply

*P. versicolor*. A photograph (text-fig. 126) by Mrs. Peter Haig Thomas of the four eggs shows very accurately the comparative sizes.

The measurements of these eggs are as follows:—

	Girth of length.	Girth of breadth.
<i>P. formosanus</i> .....	$5\frac{7}{16}$ ins.	$4\frac{1}{8}$ ins.
<i>P. versicolor</i> .....	$4\frac{1}{8}$ "	$4\frac{4}{16}$ "
F. 1, Fo. × Ve. ....	$4\frac{1}{8}$ "	$4\frac{5}{16}$ "
F. 2, Fo. × Ve. × Ve. .	$4\frac{1}{8}$ "	$4\frac{5}{16}$ "

showing a slight increase in bulk in the eggs of F. 1 and F. 2 over that of the *versicolor*.

Another character of which notice was omitted in February was the iris colour: unfortunately F. 1 ♀ died eggbound last May before it occurred to me to make an examination. The male and female *versicolor* differ in the colour of the iris, as do also the male and female *formosanus*. The male *versicolor* has a pale yellow iris, the female a soft brown centre with an outer ring of pale yellow: the male *formosanus* has a red-brown iris, the female a dark brown centre with outer ring of red-brown. Holding *formosanus*, *versicolor*, and F. 1 hens close together, it is seen that F. 1 has the female *versicolor* iris with the ring-colour a very slightly deeper shade of yellow. Again, outstretching the wings of these three hens side by side, it is observed that besides the secondaries and primaries the two groups of major coverts overlying these feathers in F. 1 ♀ also correspond exactly in pattern and colour with the same groups in the *versicolor* ♀."

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At the conclusion of the Scientific Business, Sir EDMUND G. LODER, Bt., V.P.Z.S., showed a large number of slides, including a fine series of coloured subjects, and a number of living specimens, to demonstrate the capacity of the new electric lantern which he had recently presented to the Society.

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# INDEX

## OF

### SCIENTIFIC NAMES.

- Acomus erythrophthalmus*, 909.  
*Aerochordus javanicus*, 909.  
*Actinia*, 519.  
*Ælurosaurus felinus*, 863.  
*striatidens*, 859, 863, 875.  
*Agrotera pygosticta*, 551.  
*Alee*, 774, 778, 779.  
*Aleyonium*, 518, 527.  
*Allopora*, 892, 894.  
*Alopecorhinus*, gen. nov., 859, 864, 865.  
*parvidens*, 859, 864, 875.  
*Aloposaurus*, 862.  
*Ambia novaguineensis*, 546, 549, 555.  
*Amia*, 608.  
*Ammonothea*, 511.  
*virescens*, 527.  
*Ammonothea*, 510, 511.  
*virescens*, 511.  
*Amphilius grandis*, 675.  
*oxyrhinus*, 672, 675, 676.  
*Ancistrodon piscivorus*, 633.  
*Andrya*, 587.  
*Anoplocephala hyracis hepatica*, 593, 605.  
*Anoplotænia*, 584, 603, 677.  
*dasyuri*, 694, 846, 847.  
*Anthobosca*, 696, 714, 724.  
*æthiops*, 745, 748.  
*Anthobosca albonucula*, 725.  
*albonuculata*, 728, 742, 746, 753.  
*albopilosa*, 727, 732.  
*antennata*, 728, 743, 744, 746.  
*anthracina*, 727, 733, 754.  
*apicalis*, 745.  
*arabica*, 720, 728, 739, 740.  
*argenteocincta*, 727, 732.  
*australasiae*, 725, 745-749.  
*australis*, 727, 729, 745, 754.  
*bidentata*, 746, 752, 753.  
*bipunctata*, 728, 742.  
*bipustulata*, 742, 746, 753.  
*carbonaria*, 728, 741, 742, 745.  
*chilensis*, 728, 741, 746.  
*clypeata*, 727, 735, 751, 753, 754.  
*cognata*, 727, 731.  
*crabroniformis*, 746.  
*crassicornis*, 736, 745, 751, 753.  
*donaldsoni*, 728, 737.  
*errans*, 746, 751.  
*erythronota*, 728, 737, 739, 746, 753, 754.  
*erythropygæ*, 728, 744, 746.  
*fasciculata*, 736.  
*fastuosa*, 727, 729, 753.  
*flavicornis*, 727, 730, 731, 732.  
*flavopicta*, 746, 752.  
*Anthobosca frenchi*, 745, 749, 750.  
*gilesi*, 745, 747.  
*inornata*, 736.  
*insularis*, 728, 737, 754.  
*jheringi*, 744.  
*lacteipennis*, 746, 752, 753.  
*lævifrons*, 727, 733, 734.  
*lagardei*, 745, 750.  
*leucospila*, 739.  
*longipalpa*, 745, 750.  
*melanaria*, 728, 736.  
*minima*, 728, 740.  
*moderata*, 745, 749, 753.  
*natalica*, 728, 738, 739.  
*nigra*, 745, 748.  
*nigripennis*, 745.  
*nubilipennis*, 727, 730, 735.  
*occipitalis*, 696, 727, 734.  
*sauakinensis*, 728, 740.  
*signata*, 727, 729.  
*strandii*, 727, 731.  
*torresensis*, 745, 747.  
*unicolor*, 727, 733, 734.  
*varipes*, 745, 747, 748.  
*Apenesia*, 699.  
*Aphrocallistes whiteavesianus*, 787.  
*Aphytoceeros grosalis*, 554.  
*Apomatus*, 788, 793.  
*timsii*, 784, 787, 805.  
*Aporina*, 849.  
*Aptenodytes pennanti*, 671.  
*Ara severa*, 806.

- Araucaria, 726.  
 Arboricola  
   *charltoni*, 909.  
 Arcosealpellum, 538, 539.  
 Arctictis  
   *binturong*, 909.  
 Arctogalidia  
   *stigmatica*, 909.  
 Arges  
   *cirratus*, 666, 670.  
 Argulus, 765.  
 Argusianus  
   *argus*, 909.  
 Arvicola  
   *arvalis*, 839.  
 Asellus  
   *aquaticus*, 660.  
 Astacus, 519.  
 Aulacodes  
   *brunnealis*, 548.  
   *metaloxalis*, 548.  
 Austrotiphia  
   *kirbyi*, 733.  
 Avitellina, 848.  
  
 Bagrus  
   *urostigma*, 675.  
 Balæniceps  
   *rex*, 909.  
 Balanus  
   *nubilus*, 798, 800.  
 Barbus  
   *argyrotaenia*, 672, 674,  
     676.  
   *erlangeri*, 674.  
   *minius*, 672, 674, 676.  
   *nairobiensis*, 674.  
   *neglectus*, 675.  
   *percevali*, 674.  
   *sanzibaricus*, 674.  
 Belemnitella  
   *mucronata*, 530.  
 Bertiella, 677, 694, 844.  
 Bison  
   *bonasus*, 908.  
 Boa, 621, 643.  
   *constrictor*, 628, 634.  
   *diviniloqua*, 628, 633,  
     634.  
   *reticulata*, 644.  
 Bos  
   *sondaicus*, 902, 903, 906.  
   — *birmanicus*, 906.  
   — *lowi*, 904–906.  
   — *porteri*, 906.  
 Braunsomeria, gen. nov.,  
   696, 697, 700.  
   *atriceps*, 696, 699.  
   *quadraticeps*, 696, 699–  
     753, 754.  
 Brevicella, gen. nov., 546,  
   549.  
   *emarginata*, 546, 549,  
     555.  
 Bubalus  
   *caffer*, 910.  
  
 Calamachrous  
   *albipunctatus*, 546, 554,  
     555.  
 Calliobothrium, 693.  
 Callionymus  
   *lyra*, 908.  
 Calliptilus  
   *solitarius*, 806.  
 Callosila, 726.  
 Camelus  
   *dromedarius*, 806.  
 Canis  
   *familiaris*, 556.  
 Capra  
   *pyrenaica*, 754.  
   — *victoriae*, 756.  
 Capreolus, 774, 778.  
   *capreolus*, 910.  
 Caprinia  
   *diaphanalis*, 551.  
 Cariacus, 774.  
 Carianna  
   *eristata*, 557, 558.  
 Carijoa  
   *rupicola*, 509.  
 Catreus  
   *wallichi*, 908.  
 Causus  
   *rhombicatus*, 634.  
 Cerastes  
   *vipera*, 622.  
 Ceratodus  
   *forsteri*, 607–612.  
 Cerearia  
   *ordinata*, 767, 768, 769.  
 Cercopithecus, 606.  
 Cervus, 778.  
   *affinis*, 564–575, 781.  
   *albirostris*, 558, 574.  
   *aristotelis*, 908.  
   *canadensis*, 574, 774,  
     775, 777.  
   — *wardi*, 575.  
   *cashmeriensis*, 565, 566.  
   — *macneilli*, 570.  
   *duvaucelli*, 783, 908.  
   *elaphus*, 574.  
   *eldi*, 776, 780.  
   *hanglu*, 565–575, 775,  
     777.  
   *kansuensis*, 574.  
   *macneilli*, 571–574.  
   *porcinus*, 908.  
  
 Cervus  
   *pygargus*, 559.  
   *thoroldi*, 574.  
   *wallichi*, 556, 575.  
   *scutloppus*, 575.  
 Chastostomus  
   *fischeri*, 667.  
   *lepturus*, 666, 667, 670.  
   *marginatus*, 667.  
   *palmeri*, 666, 667, 670.  
   *paucispinus*, 666, 667,  
     670.  
 Chapmannia, 600.  
   *lapica*, 603.  
 Chelys  
   *finbriata*, 911.  
 Chimarrhornis  
   *leucocephala*, 556.  
 Chironophthya  
   *variabilis*, 523, 524.  
 Chitinopoma  
   *fabricii*, 790.  
   *greenlandica*, 790, 805.  
 Chloëphaga  
   *poliocephala*, 556.  
 Chonopeltis, 765.  
   *inermis*, 766.  
 Chrysomitris  
   *uropygialis*, 910.  
 Circeis  
   *armoricana*, 796, 797.  
 Cissopis  
   *leveriana*, 911.  
 Cistecophalus  
   *arctatus*, 871.  
   *nicorhinus*, 871.  
 Cittotania, 604, 677.  
 Clarias  
   *lazeri*, 675.  
 Clarotes  
   *laticeps*, 675.  
 Clupeosoma  
   *polusalis*, 548.  
 Cœlopeltis  
   *monspessulana*, 617.  
 Colobosila, 726.  
 Colobus  
   *abyssinicus occidentalis*,  
     806.  
   *vellerosus*, 910.  
 Coluber  
   *esculapii*, 622, 633,  
     634.  
   *corais*, 633.  
   *natrix*, 613.  
 Connochaetes  
   *gnu*, 911.  
 Corallus  
   *caninus*, 643.  
   *cookii*, 628, 643.  
   *madagascariensis*, 643.

- Coris julis*, 908.  
*Coronella calenifer*, 626.  
*getula*, 617.  
*lævis*, 622.  
*Corophium acutum*, 664.  
*lacustre*, 656, 658, 664, 665.  
*triacnonyx*, 664.  
*volutator*, 658.  
*Cosila*, 724, 725.  
*apicalis*, 745.  
*argenteocincta*, 732.  
*australis*, 728.  
*biguttata*, 729.  
*carbonaria*, 741.  
*chilensis*, 725, 741.  
*donaldsoni*, 705, 737.  
*erythropygia*, 744.  
*inornata*, 736.  
*insularis*, 737.  
*jheringi*, 743.  
*(Callosila) australis*, 728.  
*(—) fasciculata*, 736.  
*(—) flavicornis*, 730.  
*(—) minuto*, 734.  
*(—) signata*, 729.  
*Orocidolomia binotalis*, 553.  
*Crucigera irregularis*, 786, 805.  
*zygophora*, 786, 805.  
*Cryptohelia*, 885.  
*Curena externalis*, 548.  
*Curicta oppositalis*, 554.  
*Cyanocorax affinis*, 806.  
*Cyclorchis*, 690.  
*Cynognathus*, 874.  
*Cysticerus fasciolaris*, 838, 850.  
*longicollis*, 839, 840.  
*Dama*, 777.  
*dama*, 781.  
*mesopotamica*, 781.  
*Dasyurotenia*, gen. nov., 677, 680, 683, 694, 695, 823.  
*robusta*, 677, 678, 679, 684, 694, 834.  
*Dasyurus ursinus*, 677.  
*Dausara amethystina*, 553.  
*Davainea*, 591, 592, 606.  
*Dendrohyrax dorsalis*, 671.  
*Dendrolagus ursinus*, 806.  
*Dendronephthya*, 505, 510, 518, 521.  
*disciformis*, 506, 519, 520, 527.  
*Diadectes*, 860.  
*Dielurodon whaitsi*, 868.  
*Dicrocælium*, 854.  
*infidum*, 854, 856.  
*Dicrogenium*, 725.  
*Dieynodon*, 871, 872.  
*laticeps*, 859, 876.  
*leoniceps*, 869.  
*lutriceps*, 859, 868, 870, 876.  
*psittacops*, 859, 869, 876.  
*tigriceps*, 868.  
*Didelphis virginiana*, 556.  
*Dilepis*, 847.  
*Dimorphoptera*, 724, 725.  
*anthracina*, 733.  
*clypeata*, 735.  
*cognata*, 731.  
*fastuosa*, 729.  
*lavifrons*, 734.  
*morosa*, 729.  
*nigripennis*, 728.  
*scabulosa*, 733.  
*scoliformis*, 728.  
*signata*, 729.  
*unicolor*, 734.  
*Dioicocestus*, 844, 848.  
*acotylus*, 831.  
*Diplostomum sirtale*, 767, 768, 769.  
*Dipteropeltis*, gen. nov., 763.  
*hirundo*, 763, 766.  
*Dipylidium*, 587.  
*Discognathus dembeensis*, 673.  
*Dissemurus paradiseus*, 556.  
*Distichopora*, 892, 894.  
*Distoma*, 856.  
*Dolops longicauda*, 763, 765.  
*Dorcephalus*, 773, 778.  
*Eccasaurus priscus*, 875.  
*Echidna*, 814.  
*Echinococcus*, 837.  
*Eirone*, 699, 725.  
*Elaphurus*, 773, 778, 780, 783.  
*davidianus*, 773, 774, 777, 779.  
*Elaphus indicus*, 909.  
*Elis*, 725.  
*alicie*, 737.  
*apimacula*, 721.  
*capitata*, 711.  
*combusta*, 724, 754.  
*dimidiata*, 716.  
*dubia*, 721.  
*ephippium*, 724.  
*fedtschenkoi*, 721.  
*major*, 696, 723.  
*sellowi*, 696, 722.  
*tricolor*, 721.  
*xanthocera*, 709.  
*(Mesa) abdominalis*, 703, 707.  
*(—) adelogamia*, 703, 706.  
*(—) alicie*, 696, 703, 704, 753, 754.  
*(—) ametalla*, 704, 713.  
*(—) apicipennis*, 696, 703, 707.  
*(—) apimacula*, 714, 719.  
*(—) asmarensis*, 704, 712.  
*(—) auriflua*, 696, 703, 705, 706.  
*(—) bengalensis*, 714, 716.  
*(—) burmanica*, 714, 722.  
*(—) capensis*, 709.  
*(—) capitata*, 704, 710.  
*(—) carbonaria*, 713.  
*(—) claripennis*, 714, 717, 718.  
*(—) clavata*, 713.  
*(—) diapherogamia*, 706.  
*(—) dimidiata*, 713, 714, 715.  
*(—) dimidiaticornis*, 714, 720, 753.  
*(—) dubia*, 714, 719.  
*(—) erythropoda*, 703, 709.  
*(—) extensa*, 714, 721.  
*(—) fedtschenkoi*, 714, 719.

## Elis

- (Mesa) *fuscepennis*, 713, 717.  
 (—) *heterogamia*, 704, 706.  
 (—) *hottentota*, 703, 708.  
 (—) *hova*, 704, 706, 707.  
 (—) *incerta*, 696, 704, 710.  
 (—) *incisa*, 713.  
 (—) *innotata*, 703, 709.  
 (—) *leta*, 714, 721.  
 (—) *longivenstris*, 696, 704, 712, 753, 754.  
 (—) *madalensis*, 713, 714, 715, 721.  
 (—) *mandibularis*, 713, 714, 715.  
 (—) *nodosa*, 704, 707, 713.  
 (—) *nursei*, 714, 721.  
 (—) *opacifrons*, 714, 719.  
 (—) *peringueyi*, 703, 708.  
 (—) *petiolata*, 713, 714, 717-719, 721.  
 (—) *picticollis*, 714, 720.  
 (—) *pyridata*, 703, 707.  
 (—) *reticulata*, 713.  
 (—) *rothneyi*, 714, 717.  
 (—) *ruficeps*, 704, 706, 754.  
 (—) *atopogamia*, 704, 706.  
 (—) *diapherogamia*, 706.  
 (—) *ruficeps*, 704.  
 (—) *rufa-femorata*, 713.  
 (—) *saussurei*, 703, 709.  
 (—) *spoliata*, 696, 704, 711.  
 (—) *torrida*, 703, 708.  
 (—) *tricolor*, 714, 720, 753, 754.  
 (—) *ustulata*, 714, 718.  
 (—) *xanthocera*, 703, 709.  
*Emydochamps*, gen. nov., 875.  
*platyceps*, 875.  
*Emydops*, gen. nov., 859, 871.  
*minor*, 859, 871, 876.

## Endothiodon, 871.

- bathystoma*, 867, 875.  
*platyceps*, 859, 867, 875, 876.  
*uniserica*, 866, 867, 875.  
*Endothiodon*  
*whaitsi*, 859, 866, 867, 875, 876.  
*Entephria*  
*glauca*, 550.  
*grisealis*, 546, 550, 555.  
*moswari*, 546, 550, 555.  
*Epimys*  
*norvegicus*, 671.  
*Equus*  
*burchelli*, 757.  
 — *chapmani*, 757.  
 — *selousi*, 757.  
 — *trausevalensis*, 757, 760.  
 — *wahlbergi*, 757.  
*kiang*, 908.  
*Erithacus*  
*komadori*, 910.  
*Errina*  
*antarctica*, 894.  
*capensis*, 894.  
*carinata*, 878, 880, 893.  
*cochleata*, 880, 893, 894.  
*dabneyi*, 880, 893, 894.  
*echinata*, 880, 881, 893.  
*fissurata*, 878, 880, 887, 894.  
*glabra*, 878, 880, 893, 894.  
*gracilis*, 878, 881, 894.  
*horrida*, 878, 880, 881, 893.  
*labiata*, 878, 880, 888, 893.  
*macrognatha*, 878, 879, 894.  
*moseleyi*, 894.  
*novae zealandiae*, 876, 877, 894.  
*pourtalesii*, 880, 881, 893.  
*ramosa*, 878-881, 893.  
*(Labiopora) antarc-*  
*tica*, 881, 882, 887, 890.  
 (—) *aspera*, 881, 888-891, 894, 895.  
 (—) *capensis*, 878, 886, 890-893, 895, 896.  
 (—) *gracilis*, 889, 890, 891.  
 (—) *moseleyi*, 881, 887, 888, 890.

## Errina

- (*Labiopora*) *novae ze-*  
*landiae*, 882-884, 889-893, 895, 896.  
 (*Spinipora*) *echinata*, 881, 895.  
*Erythrura*  
*pealei*, 911.  
*Eryx*  
*conicus*, 634.  
*jaculus*, 633, 634.  
*johni*, 633, 634.  
*Esoterodon*  
*uniserica*, 875.  
*whaitsi*, 875.  
*Eunectes*  
*marina*, 854, 856.  
*murinus*, 628, 631, 634.  
*noteus*, 634.  
*Eupodotis*  
*edwardsi*, 911.  
*Eurytremia*, 854.  
*Eutropius*  
*depressirostris*, 675.  
*Felis*  
*nebulosus*, 909.  
*onca*, 555, 806.  
*pardus*, 909.  
*tigris*, 909.  
*uncia*, 555.  
*Fiber*  
*zibethicus*, 822, 839, 840.  
*Galechirus*, 861.  
*Galeops*, gen. nov., 859, 860, 861.  
*whaitsi*, 859, 860, 875.  
*Galepus*, 861.  
*Galesaurus*, 874.  
*Gallierex*  
*cinevra*, 909.  
*Gammurus*  
*duchenii*, 657, 661.  
*locusta*, 657, 661-665.  
*pulex*, 657, 658, 660, 661.  
*zaddachi*, 656-658, 660, 661, 663, 665.  
*Gavialis*  
*gangeticus*, 909.  
*Gazella*  
*fuscifrons*, 911, 912.  
*hayi*, 911, 912.  
*isabella*, 912.  
*pelzodni*, 911.  
*Geocichla*  
*cyanonotus*, 910.



Geotiphia, 724, 726.

Giraffa

*camelopardalis anti-*  
*quorum*, 911.

— *rothschildi*, 771,  
772.

— *schillingsi*, 772.

— *thornicrofti*, 771,  
772, 773.

— *tippelskirchi*, 771,  
772.

Girardinus

*pareiloides*, 906.

Glyphodes

*caesalis*, 552, 553.

*magnificalis*, 546, 552,  
555.

*nigricincta*, 546, 552,  
555.

*pyfferæ*, 546, 554,  
555.

*polyzonalis*, 552.

*pseudocæsalis*, 546, 552,  
553, 555.

Gorgonia

*suberosa*, 524.

Gorgonops

*torvus*, 861.

Govia, 770.,

Graphiurus

*spurrælli*, 555.

Gypætus

*barbatus*, 806.

Hancockia

*endactylota*, 770.

Haplochilus

*scæfasciatus*, 911.

Hemidactylus

*bourringii*, 909.

*frenatus*, 909.

*teschenavultii*, 909.

Hemistomum, 767, 770.

Hemitragus

*jemtæicus*, 556.

Hesperornis, 819.

Holothuria, 519.

Ilyana

*hyæna*, 555.

Hyalopomatopsis, 792.

*langerhansi*, 791.

*marenzelleri*, 791.

*occidentalis*, 791.

Hydrochoerus

*hydrochoerus*, 911.

Hydropotes, 774.

Hymenolepis

*acuta*, 687.

*murina*, 822.

*reticulata*, 603.

*villosus*, 831.

Hyracotenia, gen. nov.,

576, 579, 593, 604.

*capensis*, 576.

*hyracis*, 576, 594, 596,  
597, 601, 605.

*procavia*, 604, 605.

Hyroides

*divinus*, 804.

*grönlandica*, 790.

*norvegica grönlandica*,  
790.

Icterus

*xanthornus*, 806.

Ictidognathus

*hemburyi*, 859, 865,  
875.

*parvulus*, 865, 866.

Ictidopsis, gen. nov., 859,  
872, 874.

*elegans*, 859, 872, 873,  
876.

Ictidosuchus, 861.

Inermicapsifer, 581, 582,  
590, 594, 595, 599,

603, 607, 688, 692,  
847.

sp., 593, 605.

*capensis*, 576, 577, 580,  
586, 588, 591, 592,

593, 600, 602, 606.

*criticus*, 593.

*hyracis*, 577, 578, 579,  
585, 586, 587, 588,

591, 592, 606.

*interpositus*, 592.

*pagenstecheri*, 593.

*setti*, 577, 578, 592,  
606.

Iswara, 715.

Jassa, 656.

Kachuga

*dhongoka*, 909.

Kistecephalus

*arctatus*, 871.

Labeo

*cylindricus*, 673.

*neumanni*, 673.

*percivali*, 672, 673,  
676.

Labiopora, 876, 879, 880,  
881, 884, 885.

*antarctica*, 887, 890,  
893, 894.

Labiopora

*moseleyi*, 878, 888, 893,  
894.

Lacerta, 614, 626, 627,  
631, 644.

*murialis*, 643, 807.

Lachesis

*gramineus*, 623.

Laospira, 793, 799.

Lama

*pacus*, 556.

Lanius

*cristatus*, 910.

Larus

*hemprichi*, 910.

Leptocheirus

*pilosus*, 656, 658.

Ligula, 824.

Linstownia, 677.

Lioheterodon

*madagascariensis*, 634.

Lithophyton

*arborescens*, 511.

Lithophytum, 511, 513.

*arborescens*, 511, 517,  
527.

Lobophytum, 527.

Lomanotus

*geni*, 770.

Lophophorus

*impeyanus*, 908.

Lophortyx

*douglasi*, 911.

Lycosuchus, 862.

Lystrosaurus, 873, 874.

Macalla

*arruensis*, 546, 547,  
555.

*miosvari*, 546, 547,  
555.

*olivalis*, 546, 547, 555.

*syrichtusalis*, 547.

Madrepore, 519.

Margarosticha

*plumbealis*, 546, 549,  
555.

Maurillus, 725.

Mazama, 778.

*bricenii*, 783.

Meleagris

*ocellata*, 909.

Melitodes

*albitincta*, 506, 525.

Mera

*pusilla*, 797.

Meria

*abdominalis*, 703.

Merops

*apiaster*, 911.

Millepora  
   *aspera*, 879, 881.  
 Moniezia, 604, 677, 692,  
   695.  
 Mormyrops  
   *deliciosus*, 673.  
 Mormyrus  
   *kannume*, 673.  
 Motacilla  
   *citreola*, 910.  
 Mungos  
   *brachyurus*, 909.  
   *ichneumon*, 909.  
 Myiarchus  
   *tyrannulus*, 911.  
 Myzine, 697, 725.  
   *abdominalis*, 696, 703,  
     754.  
   *albomaculata*, 742.  
   *anthracina*, 714, 733.  
   *apinacula*, 719.  
   *bipunctata*, 742.  
   *bengalensis*, 716.  
   *braunsi*, 696, 700, 753,  
     754.  
   *burmanica*, 722.  
   *capitata*, 710.  
   *carbonaria*, 741.  
   *ceylonica*, 717.  
   *claripennis*, 718.  
   *clavata*, 713.  
   *combusta*, 696, 714,  
     724.  
   *constrictiventris*, 696,  
     701, 754.  
   *dimidiata*, 715.  
   *dimidiaticornis*, 720.  
   *erythropygga*, 744.  
   *fastuosa*, 729.  
   *flavicornis*, 741.  
   *fuscipennis*, 717.  
   *hortata*, 718.  
   *insularis*, 737.  
   *leta*, 721.  
   *leccintei*, 742.  
   *levifrons*, 734.  
   *madraspataana*, 715.  
   *nodosa*, 713.  
   *orientalis*, 714.  
   *pallida*, 714.  
   *petiolata*, 717.  
   *rothneyi*, 717.  
   *ruficeps*, 706.  
   *rufifrons*, 702.  
   *sabulosa*, 733.  
   *sauakinensis*, 696,  
     740.  
   *signata*, 729.  
   *stigma*, 696, 699, 753,  
     754.  
   *swalei*, 700, 701.

Myzine  
   *tricolor*, 720.  
   *unbratica*, 696, 702.  
   *unicolor*, 734.  
   *violaceipennis*, 715.  
   *xanthocera*, 709.  
 Nacoleia  
   *perdentalis*, 551.  
 Naia  
   *melanolenca*, 910.  
 Naja  
   *tripudians*, 851.  
 Neochmia  
   *phaeton*, 911.  
 Neogensis  
   *flavoplagialis*, 548.  
 Nephthée, 510, 511.  
 Nephthya, 510, 512, 513,  
   519.  
   *albida*, 516.  
   *bedfordi*, 505, 506, 514,  
     516, 517, 527.  
   *celosa*, 517.  
   *chabrotii*, 511, 512, 517,  
     518, 527.  
   *cordieri*, 511.  
   *elongata*, 516.  
 Noorda  
   *arfakensis*, 546, 553,  
     555.  
   *nigripunctalis*, 553.  
 Nototragus  
   *melanotis*, 909.  
 Numida  
   *ptilorrhyncha*, 576,  
     605.  
 Nursen, 725.  
 Nymphula  
   *chryseis*, 548.  
   *polystictalis*, 548.  
 Nythosaurus, 873.  
   *browni*, 859, 874,  
     876.  
   *larvatus*, 872, 874.  
 Odocoileus  
   sp., 773, 774, 778, 780,  
     782.  
   *americanus*, 783.  
   *hemionus*, 783.  
   *savannarum*, 781.  
 Odontothynnus, 696,  
   724.  
   *bidentatus*, 752.  
   *lacteipennis*, 752.  
 Omphisa  
   *repetitalis*, 553.

Omphisa  
   *variegata*, 546, 553,  
     555.  
 Oochoristica, 677, 847.  
 Ophiocephalus  
   *punctatus*, 911.  
 Ophiophagus  
   *bangarus*, 617, 625.  
 Opisthoctenodon, 859,  
   868.  
 Ornithorhynchus, 814,  
   866.  
 Otiditænia, 584, 590,  
   591.  
   *eupodotidis*, 583.  
 Otocinelus  
   *maculipennis*, 666, 668,  
     670.  
   *nigricauda*, 668.  
   *perforatus*, 668.  
 Oudenodon, 859, 872.  
   *bolorhinus*, 868.  
   *magnus*, 866.  
 Ovis  
   *burriel*, 556.  
 Oxyloricaria  
   *leightoni*, 666, 669,  
     670.  
   *tamanæ*, 666, 669, 670.  
 Pagyda  
   *botydalis*, 551.  
   *fumosa*, 546, 551,  
     555.  
 Paradexiospira, 793.  
 Paralæospira, 799.  
 Paraspongodes  
   *crassa*, 506, 523.  
 Pareiasaurus, 860, 861,  
   863, 869.  
 Pelea  
   *capreolus*, 910.  
 Pelias  
   *berus*, 643.  
 Pelophilus  
   *madagascariensis*, 612,  
     633.  
 Peltidocotyle, 694.  
 Peraneles, 819.  
 Perisyntrocha  
   *suffusa*, 546, 548, 555.  
 Petrophila  
   *erythragastra*, 909.  
 Phasianus  
   *formosus*, 540, 541, 545,  
     912, 913.  
   *gennæus*, 540.  
   *torquatus*, 540.  
   *versicolor*, 540-542,  
     545, 546, 912, 913.

- Phryganodes*  
*analis*, 551.  
*centrabalis*, 551.  
*erubusalis*, 551.  
*tetraplayalis*, 551.  
*usitatis*, 551.  
*Phyllobothrium*, 694.  
*Pileocera*  
*diplutyla*, 548.  
*cyminisalis*, 548.  
*torsiculis*, 548.  
*Pilocrocis*  
*angulifera*, 546, 553,  
555.  
*Platophrys*  
*podas*, 556.  
*Platynosomum*, 854.  
*Plecostomus*  
*hondæ*, 666, 670.  
*Plerocercus*, 839.  
*Plesia*  
*abdominalis*, 707.  
*asmarensis*, 712.  
*carbonaria*, 710, 713.  
*continua*, 696, 703.  
*dubia*, 719.  
*erythronota*, 696, 738.  
*fedtschenkoi*, 719.  
*incisa*, 712, 713.  
*leucospila*, 696, 739.  
*mandalensis*, 716.  
*melanaria*, 696, 736.  
*nursei*, 721.  
*picticollis*, 720.  
*reticulata*, 713.  
*rufa-femorata*, 713.  
*tartura*, 719.  
*(Mesa) abdominalis*,  
707.  
(—) *adelogamia*, 706.  
(—) *atopogamia*, 706.  
(—) *diapherogamia*,  
706.  
(—) *disjuncta*, 706.  
(—) *erythrepoda*, 709.  
(—) *heterogamia*, 706.  
(—) *hottentota*, 708.  
(—) *hova*, 707.  
(—) *innotata*, 709.  
(—) *mandibularis*, 715.  
(—) *opacifrons*, 719.  
(—) *peringueyi*, 708.  
(—) *purpureipennis*,  
715.  
(—) *saussurei*, 709.  
*Pacilotiphia*  
*albomaculata*, 719.  
*Pollicipes*, 530, 537.  
*Polyplectron*  
*bicalcaratum*, 909.  
*chinquis*, 557.  
*Polypterus*  
*snegalus*, 910.  
*Porella*  
*antarctica*, 881, 887.  
*Pristerodon*, 859, 868.  
*Pristerognathus*  
*platyrhinus*, 859, 863,  
864, 875.  
*polyodon*, 864.  
*Procuvia*  
*capensis*, 576, 593.  
*Procolophon*, 874.  
*Prodieynodon*  
*beaufortensis*, 859, 867,  
876.  
*pearstonensis*, 868.  
*Proptopterus*  
*annectens*, 807.  
*Prorodes*  
*mimica*, 551.  
*Prospirorbis*, 792.  
*Proterogynotenia*, 685.  
*Protolaespira*, subgen.  
nov., 784, 792, 798.  
*Protula*  
*atypha*, 790.  
*capensis*, 790.  
*diomedea*, 790.  
*pacifica*, 784, 785, 805.  
*superba*, 790.  
*Pseudomeria*, 699.  
*Pseudotantalus*  
*ibis*, 556.  
*Psilacabaria*  
*gracillima*, 506, 525.  
*Pygospila*  
*tyres*, 553.  
*Pyrausta*  
*alentialis*, 554.  
*deductalis*, 554.  
*flammealis*, 546, 554,  
555.  
*occultilinea*, 554.  
*Python*  
*molurus*, 638.  
*reticulatus*, 806.  
*regius*, 628.  
*sebae*, 633, 634.  
*spilotes*, 626.  
*Rangifer*, 774, 778.  
*Rehimena*  
*cissophora*, 551.  
*Rhinoceros*  
*unicornis*, 908.  
*Romanchella*, 793.  
*Rucervus*, 778.  
*duvaucelli*, 776, 780.  
*Rusa*, 776, 778, 780.  
*aristotelis*, 775, 781.  
*Sameodes*  
*polythliptalis*, 553.  
*Sarcophytum*, 527.  
*Scalpellum*  
*accumulatum*, 528-530,  
537-539.  
*arcuatum*, 528-531.  
*comptum*, 537, 538.  
*darwinianum*, 530,  
535.  
*fossula*, 531, 533, 537,  
538, 539.  
*gallicum*, 538.  
*hastatum*, 530, 539.  
*maximum*, 531.  
— *cylindraceum*, 530,  
538, 539.  
*simplex*, 528, 530,  
538, 539.  
*solidulum*, 530, 537,  
538, 539.  
*trilineatum*, 528, 530,  
531, 538, 539.  
*Sceliodes*  
*grisealis*, 546, 550,  
555.  
*Sclerogorgia*  
*suberosa*, 524.  
*Sclerophytum*, 509.  
*palmatum*, 507, 508.  
*pinulatum*, 505, 506,  
507, 508, 527.  
*viride*, 508.  
*Scylacosaurus*, 861, 864.  
*Scymnognathus*, gen.  
nov., 859, 861, 862.  
*whaitsi*, 859, 861, 875.  
*Scymnosaurus*, 863.  
*Seimnopithecus*  
*pileatus*, 806.  
*Serpula*  
*columbiana*, 784, 785,  
786, 801, 802, 805.  
*jukesii*, 786.  
*spirillum*, 796.  
*splendens*, 784, 785,  
786.  
*triquetra*, 780.  
*vitrea*, 793.  
*zygophora*, 786.  
*Sierolomorpha*, 725.  
*Siphonogorgia*  
*variabilis*, 506, 523.  
*Sphenocercus*  
*sphenurus*, 908.  
*Sphenodon*, 643.  
*Spinipora*, 876, 878, 879,  
880, 881, 891.  
*Spirorbis*  
*affinis*, 802.  
*aggregatus*, 795.

## Spirorbis

- ambilateralis*, 784, 792, 795, 798, 799, 805.  
*argutus*, 795.  
*armoricanus*, 794, 797.  
*bellulus*, 794.  
*beneti*, 795.  
*bernardi*, 795.  
*borealis*, 796, 804.  
*cancellatus*, 792, 794, 796.  
*carinatus*, 802.  
*chiparedei*, 795.  
*comptus*, 794.  
*cornu-arietis*, 795, 798.  
*corrugatus*, 794.  
*evolutus*, 793.  
*fabricii*, 802.  
*foraminosus*, 794.  
*formosus*, 794.  
*granulatus*, 802.  
*koehleri*, 795.  
*lævis*, 795.  
*langerhansi*, 795, 801, 805.  
*lebruni*, 795.  
*levinseni*, 795.  
*lucidus*, 796.  
*maldardi*, 795.  
*marioni*, 794.  
*mediterraneus*, 795.  
*medius*, 784, 793, 795, 800, 805.  
*militaris*, 795.  
*mörchi*, 795, 801, 805.  
*pagenstecheri*, 794.  
*patagonicus*, 795.  
*perrieri*, 795.  
*pseudocorrugatus*, 794.  
*pusilla*, 794, 797.  
*pusilloides*, 794, 797, 805.  
*quadrangularis*, 795, 802.  
*racemosus*, 784, 795, 798, 799, 805.  
*rugatus*, 794.  
*semidentatus*, 794.  
*similis*, 795.  
*spirillum*, 794, 796, 797, 805.  
*spirorbis*, 795.  
*validus*, 795, 800, 805.  
*variabilis*, 795, 802.  
*verruca*, 793, 795, 800.  
*violaceus*, 794.  
*vitreus*, 793, 794, 805.  
*(Dexiospira) spirillum*, 796.

## Spirorbis

- (Lavospira) asperatus*, 800.  
 (—) *langerhansi*, 801.  
 (—) *medius*, 800.  
 (—) *mörchi*, 801.  
 (—) *quadrangularis*, 802.  
 (—) *validus*, 800.  
 (—) *variabilis*, 802.  
*(Paradexiospira) vitreus*, 793.  
*(Protolavospira) ambilateralis*, 798.

## Spizætus

- linnaeatus*, 910.  
*Spongodes*, 510, 511, 518, 519, 520, 521.  
*celosia*, 512, 513, 518.  
*nephthyæformis*, 512, 518.

- Sponodia*, 518, 520, 521.  
*Stereonephthya*, 510, 518, 519, 520.  
*lutea*, 505, 506, 521, 523, 527.

## Stericta

- rurcalis*, 546, 548, 555.

## Styphlodora

- bascaniensis*, 855, 856.  
*condita*, 855, 856.  
*horrida*, 851, 854.  
*naja*, 851, 852, 854.  
*serrata*, 854, 855.  
*similis*, 855.

## Subergorgia

- suberosa*, 506, 524.

## Sylepta

- dinawa*, 546, 551, 555.  
*leucodonta*, 551.  
*polydonta*, 551.

## Synodontis

- geledensis*, 675.  
*schull*, 675.

## Syrnium

- uralense*, 909.

## Tachypterus

- crassicornis*, 751.

## Tania

- crassiceps*, 839.  
*crassicollis*, 838.  
*ghondkorensis*, 593.  
*paronai*, 593.  
*spatula*, 593.  
*(Anoplocephala) gondokorensis*, 605.  
 (—) *spatula*, 605.

## Taognathus

- megalodon*, 867.

## Tapinocephalus

- atherstoni*, 859.

## Tapiurus

- indicus*, 909.

## Taurops, gen. nov., 859.

- macradon*, 859, 875.

## Taurotragus

- oryx*, 806.

## Telesto

- prolifera*, 509, 510.

- ritsei*, 509.

- rapicola*, 506, 509, 510.

- (Carijoa) rapicola*, 509.

## Tetrabothrium, 585.

## Thamnobia

- cambaiensis*, 909.

## Thaumalea

- amhersti*, 544.

- obscura*, 544.

- picta*, 544.

## Thecla

- bertha*, 897, 902.

- biblia*, 901.

- canpa*, 901, 902.

- castrena*, 900, 902.

- datitia*, 901, 902.

- esmeralda*, 900, 902.

- fancia*, 897, 902.

- fernanda*, 899, 902.

- gaina*, 898.

- gispa*, 896.

- hamila*, 896, 902.

- janias*, 900.

- japola*, 898, 902.

- lenona*, 899.

- molena*, 899, 902.

- nora*, 899, 902.

- nubilum*, 899.

- phrosine*, 900.

- punctatum*, 897.

- schausa*, 898, 902.

- sierana*, 897, 902.

- tadila*, 901.

## Thelognathus, 874.

## Thrasactis

- harpysia*, 806.

## Thynnus, 725.

- antennatus*, 743.

- cathreini*, 746.

- fischeri*, 747.

- reischii*, 748.

- stolzi*, 748.

## Thysanotænia, 576, 584, 607.

- gambiana*, 579, 581, 582, 583, 585, 586, 587, 590, 602, 606.

- Thysanotænia*  
*lemuris*, 583, 585, 606, 686.  
*Tilapia*  
*alcalica*, 676.  
*grahami*, 676.  
*nilotica*, 675.  
*percivali*, 672, 676.  
*Tiphia*  
*capensis*, 709.  
*bipunctata*, 742.  
*Totanus*  
*calidris*, 647.  
*Toxostoma*  
*cinereum*, 910.  
*Triplotænia*, 677.  
*Trochalopterum*  
*morrisonianum*, 910.  
*Tropidonotus*  
*fasciatus*, 624, 626, 633.  
*natria*, 612, 613, 632, 634, 640, 643, 646, 647.  
*ordinatus sirtalis*, 767.  
*Tropidonotus*  
*tesselatus*, 622.  
*Tympanuchus*  
*americanus*, 556.  
*Urocystidium*, gen. nov., 840.  
*gemmiparum*, 822, 824, 826, 828, 833, 840, 841.  
*Ursus*  
*muritimus*, 556.  
*Vipera*  
*berus*, 622.  
*russelli*, 910.  
*Viverra*  
*civetta*, 909.  
*Wrightella*, 526.  
*robusta* 505, 503, 525, 527.  
*Xanthomelana*  
*schematias*, 550.  
*Xenia*, 509.  
*Xenocæra*  
*bufonium*, 668.  
*heterorhynchus*, 666, 668, 670.  
*multispinis*, 666, 668, 670.  
*stigmaticum*, 668.  
*Xenopharynx*, gen. nov., 851.  
*solus*, 851, 852.  
*Zamenis*  
*fasciolatus*, 909.  
*genonensis*, 631, 633, 634.  
*Zinckenia*  
*lophoceralis*, 551.  
*Zschokkea*, 590.  
*Zschokkeella*, 576, 591, 602, 603, 606, 607, 688, 692.  
*linstowi*, 590.

# INDEX

OF

## ILLUSTRATIONS.

- Elurosauros striatidens*, Pl. XCI.  
p. 859.
- Alopecorhinus parvidens*, Pl. XCI.  
p. 859.
- Ambia novaguinensis*, Pl. LXVIII.  
p. 546.
- Ammothea virescens*, Pl. LXI. p. 505.
- Amphilius oxyrhinus*, Pl. LXXIX.  
p. 672.
- Anthobosca albomaculata*, Pl. LXXXI.  
p. 696.
- *anthracina*, Pl. LXXXII. p. 696.
- *australasie*, Pl. LXXXIII. p. 696.
- *australis*, Pls. LXXXII.,  
LXXXIII., p. 696.
- *clypeata*, Pls. LXXXI.-LXXXIII.,  
p. 696.
- *crassicornis*, Pl. LXXXI. p. 696.
- *erythronota*, Pls. LXXXI.,  
LXXXII., p. 696.
- *fastuosa*, Pl. LXXXI. p. 696.
- *insularis*, Pls. LXXXII.,  
LXXXIII., p. 696.
- *moderata*, Pl. LXXXI. p. 696.
- Aponatus timsii*, Pl. LXXXVII. p. 784.
- Barbus argyrotænia*, Pl. LXXIX. p. 672.
- *minus*, Pl. LXXIX. p. 672.
- Bos sondaicus*, Fig. 123, p. 903.
- *lowi*, Figs. 124, 125, pp. 904,  
905.
- Braunsomeria quadraticeps*,  
Pls. LXXXI., LXXXII., p. 696.
- Brevicella emarginata*, Pl. LXVIII.  
p. 546.
- Calamachrous albipunctalis* (var.),  
Pl. LXVIII. p. 546.
- Cariama cristata*, Pl. LXIX. p. 546.
- Ceratodus forsteri*, Figs. 84, 85, pp. 610,  
611.
- Cercaria ordinata*, Fig. 107, p. 768.
- Cervus*, Fig. 110, p. 778.
- *canadensis*, Fig. 108, p. 775.
- *hanglu*, Figs. 70, 108, pp. 566, 775.
- *macneilli*, Fig. 71. p. 571.
- *wallichii*, Figs. 66-69, pp. 559,  
561, 563, 565.
- Chætostomus lepturus*, Pl. LXXV.  
p. 666.
- *palmeri*, Pl. LXXV. p. 666.
- *paucispinis*, Pl. LXXV. p. 666.
- Chitinopoma greenlandica*, Pl.  
LXXXVIII. p. 784.
- Corophium lacustre*, Pl. LXXIV. p. 656.
- Crucigera irregularis*, Pl. LXXXVII.  
p. 784.
- *zygophora*, Pl. LXXXVII. p. 784.
- Dasyurotænia robusta*, Figs. 92-101,  
pp. 677-679, 681, 682, 684, 686, 688,  
690, 691.
- Dendroncephthya disciformis*, Pl. LXIII.  
p. 505.
- Dieynodon laticeps*, Pl. XCII. p. 859.
- *luriceps*, Pl. XCII. p. 859.
- *psittacops*, Pl. XCII. p. 859.
- Diplostomum sirtale*, Fig. 107, p. 768.
- Dipteropeltis hirundo*, Pl. LXXXIV.  
p. 763.
- Eccasaurus priscus*, Pl. XC. p. 859.
- Elaphurus*, Fig. 110, p. 778.
- *davidianus*, Fig. 111, p. 779.
- Elis combusta*, Pl. LXXXII. p. 696.
- (*Mesa*) *alicia*, Pls. LXXXI.,  
LXXXIII., p. 696.

- Elis (Mesa) dimidiaticornis*, Pl. LXXXI.  
p. 696.
- (—) *longiventris*, Pls. LXXXI.,  
LXXXIII., p. 696.
- (—) *ruficeps*, Pls. LXXXII.,  
LXXXIII., p. 696.
- (—) *tricolor*, Pls. LXXXI.,  
LXXXII., p. 696.
- Eurydops minor*, Pl. XCIII. p. 859.
- Eudothiodon platycephs*, Pl. XCIII.  
p. 859.
- *whaitsi*, Pl. XCIII. p. 859.
- Entephria grisealis*, Pl. LXVIII., p. 546.
- *mioswari*, Pl. LXVIII. p. 546.
- Equus burchelli*, Figs. 102–106, pp. 758–  
762.
- Errina (Labiopora) aspera*, Pl. XCV.  
p. 876.
- (—) *capensis*, Pl. XCV. p. 876.
- (—) *novae zelandiae*, Pls. XCIV.–  
XCVI., p. 876.
- (*Spinipora*) *echinata*, Pl. XCV.  
p. 876.
- Galeops whaitsi*, Pl. XCI. p. 859.
- Gannarus locusta*, Pl. LXXIII. p. 656.
- *zaddachi*, Pls. LXXIII., LXXIV.,  
p. 656.
- Giraffa camelopardalis thornicrofti*,  
Pl. LXXXVI. p. 771.
- Glyphodes magnificolis*, Pl. LXVIII.  
p. 546.
- *nigricincta*, Pl. LXVIII. p. 546.
- *pfeifferæ* (var.), Pl. LXVIII.  
p. 546.
- *pseudocæsalis*, Pl. LXVIII. p. 546.
- Hancockia eudactylota*, Pl. LXXXV.  
p. 770.
- Hyracotenia hyracis*, Figs. 79–83,  
pp. 594, 596, 597, 601.
- Ictidognathus hemburyi*, Pl. XCI. p. 859.
- Ictidopsis elegans*, Pl. XCIII. p. 859.
- Luermcapsifer capensis*, Figs. 72–78,  
pp. 577, 580, 586, 588, 592.
- Labco percivali*, Pl. LXXVIII. p. 672.
- Lithophytum arboreum*, Pl. LXI. p. 505.
- Macalla arruensis*, Pl. LXVIII. p. 546.
- *mioswari*, Pl. LXVIII. p. 546.
- *ovalis*, Pl. LXVIII. p. 546.
- Margurosticha plumbealis*, Pl. LXVIII.  
p. 546.
- Myzine abdominalis*, Pls. LXXXII.,  
LXXXIII. p. 696.
- *braunsi*, Pls. LXXXI., LXXXII.,  
p. 696.
- *constrictiventris*, Pls. LXXXII.,  
LXXXIII., p. 696.
- Myzine stigma*, Pls. LXXXI., LXXXII.,  
p. 696.
- Nephtya bedfordi*, Pls. LXII., LXIII.,  
p. 505.
- *chabrolii*, Pls. LXI., LXII., p. 505.
- Noorda arfakensis*, Pl. LXVIII. p. 546.
- Nyctosaurus browni*, Pl. XCIII. p. 859.
- Odocoileus*, Fig. 110, p. 778.
- sp., Fig. 112, p. 782.
- Omphisa variegata*, Pl. LXVIII. p. 546.
- Otocinclus maculipinnis*, Pl. LXXVII.  
p. 666.
- Oxylocaria leightoni*, Pl. LXXVII.  
p. 666.
- *tunanzæ*, Pl. LXXVII. p. 666.
- Pagoda fumosa*, Pl. LXVIII. p. 546.
- Perisynthrocha suffusa*, Pl. LXVIII.  
p. 546.
- Phasianus formosanus*, Pls. LXIV.–  
LXVII., p. 539; Fig. 126, p. 912.
- *Phasianus versicolor*,  
Pls. LXIV.–LXVII., p. 539;  
Fig. 126, p. 912.
- *versicolor*, Pls. LXIV.–LXVII.,  
p. 539; Fig. 126, p. 912.
- Pilocrocis angulifera*, Pl. LXVIII.  
p. 546.
- Plecostomus hondæ*, Pl. LXXVI. p. 666.
- Pristerognathus platyrhinus*, Pl. XCI.  
p. 859.
- Prodicymodon beaufortensis*, Pl. XCIII.  
p. 859.
- Protula pacifica*, Pl. LXXXVII. p. 784.
- Pyrausta flammealis*, Pl. LXVIII.  
p. 546.
- Rucervus duvaucelli*, Fig. 109, p. 776.
- Rusa*, Fig. 110, p. 778.
- *aristotelis*, Fig. 108, p. 775.
- Sculpellum accumulatum*, Fig. 64,  
p. 529.
- *arcuatum*, Figs. 64, 65, pp. 529,  
534.
- *hastatum*, Fig. 64, p. 529.
- *simplex*, Fig. 64, p. 529.
- *trilineatum*, Fig. 64, p. 529.
- Sceliodes grisealis*, Pl. LXVIII. p. 546.
- Sclerophytum pinnulatum*, Pls. LXII.,  
LXIII., p. 505.
- Scymnognathus whaitsi*, Pl. XC. p. 859.
- Serpula columbiana*, Pl. LXXXVII.  
p. 784.
- Spirorbis ambilateralis*, Pl. LXXXVIII.  
p. 784.
- *asperatus*, Pl. LXXXIX. p. 784.
- *langerhansii*, Pl. LXXXIX. p. 784.
- *medius*, Pl. LXXXIX. p. 784.

*Spirorbis mürchi*, Pl. LXXXIX. p. 784.  
 — *pusilloides*, Pl. LXXXVIII.  
     p. 784.  
 — *racemosus*, Pl. LXXXIX. p. 784.  
 — *spirillum*, Pl. LXXXVIII. p. 784.  
 — *validus*, Pl. LXXXIX. p. 784.  
 — *vitreus*, Pl. LXXXVIII. p. 784.  
*Stereonephthya lutea*, Pl. LXIII. p. 505.  
*Stericta rurealis*, Pl. LXVIII. p. 546.  
*Styphlodora najæ*, Fig. 122, p. 852.  
*Sylepta dinawa*, Pl. LXVIII. p. 546.

*Taurops macrodon*, Pl. XC. p. 859.  
*Thecla bertha*, Pl. XCVII. p. 896.  
 — *campa*, Pl. XCVII. p. 896.  
 — *castanea*, Pl. XCVII. p. 896.  
 — *datitia*, Pl. XCVII. p. 896.  
 — *esmeralda*, Pl. XCVII. p. 896.  
 — *fancia*, Pl. XCVII. p. 896.  
 — *fernanda*, Pl. XCVII. p. 896.  
 — *hamila*, Pl. XCVII. p. 896.  
 — *japola*, Pl. XCVII. p. 896.

*Thecla molenæ*, Pl. XCVII. p. 896.  
 — *nora*, Pl. XCVII. p. 896.  
 — *schausa*, Pl. XCVII. p. 896.  
 — *sivana*, Pl. XCVII. p. 896.  
*Tilapia percivali*, Pl. LXXIX. p. 672.  
*Tropidonotus natrix*, Pls. LXX.—LXXII.  
     p. 612; Figs. 86-91, pp. 616, 617,  
     619, 620, 627, 629.

*Urocystidium gemmiparum*, Figs. 113-  
 121, pp. 824, 826, 828, 833, 835, 841,  
 843, 845, 846.

*Wrightella robusta*, Pls. LXII., LXIII.,  
 p. 505.

*Xenocara heterorhynchus*, Pl. LXXVI.  
     p. 606.  
 — *multispinis*, Pl. LXXVI. p. 606.  
*Xenopharynx solus*, Fig. 122, p. 852.



ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

October 29th, 1912.

Prof. E. A. MINCHIN, M.A., F.R.S., Vice-President, in the Chair.

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The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a Report on the Additions that had been made to the Society's Menagerie during the months May to September, 1912.

Mrs. ROSE HAIG THOMAS, F.Z.S., exhibited the eggs of *Phasianus versicolor*, *P. formosus*, and of the  $F_1$  and  $F_2$  offspring of an experimental cross between a male *P. versicolor* and a female *P. formosus*. She drew attention to the resemblance in size of the eggs of the offspring and of the male parent species, whereas the expectation was a likeness to those of *P. formosus*, thus showing the descent through the male to his female offspring of the small egg of his species.

Mr. R. LYDEKKER, F.R.S., F.Z.S., contributed a note pointing out that, owing to an unfortunate mistake in labelling, the Gazelle he described in the Society's 'Proceedings' for 1911 as a new species, *Gazella hayi*, was really *G. fuscifrons*.

Mr. LYDEKKER also described the Bornean Bantin as a new race to be distinguished from the typical Javan Bantin by the

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\* This Abstract is published by the Society at its offices, Zoological Gardens, Regent's Park, N.W., on the Tuesday following the date of Meeting to which it refers. It will be issued, along with the 'Proceedings,' free of extra charge, to all Fellows who subscribe to the Publications; but it may be obtained on the day of publication at the price of *Sixpence*, or, if desired, sent post-free for the sum of *Six Shillings* per annum, payable in advance.

more upright direction and less outward curvature of the horns of the male.

Mr. E. G. BOULENGER, F.Z.S., Curator of Reptiles, read a paper dealing with the breeding-habits of the "Millions" Fish (*Girardinus pacciloides*) from observations made in the Society's Gardens, and recorded cases of the male of this species breeding before assuming the livery of its sex. The author drew attention to parallel cases among fishes, in which, however, except in one case, the question was one of degree only.

The Rev. T. R. R. STEBBING, M.A., F.R.S., F.Z.S., read a paper entitled "The Crustacea Isopoda of the 'Porcupine' Expedition." In the tribe Flabellifera, family Gnathiidae, two new species were assigned to the genus *Gnathia*, and a new genus was instituted to receive a new species called *Akidognathia cedipus*. In the tribe Asellota a new family, Thambematidae, was proposed for a new genus with a new species named *Thambema amicorum*. *Gnathia cristatipes*, sp. n., owed its name to the striking processes on the second and third joints of the second pereopods, its head in dorsal view being almost circular. *Gnathia schistifrons*, sp. n., had a head much wider than long, with a rounded notch in the middle of the front, a peculiarity which it shared with *G. caeca*, Richardson, 1911, without sharing the blindness of that species. *Akidognathia cedipus*, gen. et sp. n., deserved its specific name alike by the gouty appearance of the second pereopod and the problems which required solving in regard to its mouth-organs; while, contrary to the custom of the family, the adult male appeared to have at least one pair of maxillae. In the Asellota *Thambema amicorum*, gen. et sp. n., seemed to be anomalous in the tribe by having only four pairs of pleopods in the male and no uropods; its narrowly cylindrical shape was also unusual.

This memoir will be published in the 'Transactions' in due course.

Dr. F. E. BEDDARD, M.A., F.R.S., F.Z.S., Prosector to the Society, read a paper on the Anatomy and Systematic Arrangement of the Cestoidea, in which he gave an account of six species of Tapeworms from Reptiles, belonging to the genus *Ichthyotania* (s. l.).

Mr. E. DUKINFIELD JONES, F.Z.S., F.E.S., communicated a short paper containing the descriptions of thirteen new species of Butterflies of the genus *Thecla* which he had collected at various localities in S.E. Brazil.

## LANTERN DEMONSTRATION.

At the conclusion of the Scientific Business, Sir EDMUND G. LODER, Bt., V.P.Z.S., showed a large number of slides, including a fine series of coloured subjects, and a number of living specimens, to demonstrate the capacity of the new electric lantern which he had recently presented to the Society.

The next Meeting of the Society for Scientific Business will be held on Tuesday, November 12th, 1912, at half-past Eight o'clock P.M., when the following communications will be made:—

H. R. HOGG, F.Z.S.

Some Falkland Island Spiders.

BRUCE F. CUMMINGS.

On some Points in the Anatomy of the Mouth-parts of the Mallophaga.

F. F. LAIDLAW, M.A., F.Z.S.

Contributions to a Study of the Dragonfly Fauna of Borneo.  
—Part I. The Corduliinæ: the Genus *Amphicnemis*.

H. LYSTER JAMESON, M.A., D.Sc., Ph.D., F.Z.S., and WILLIAM  
NICOLL, M.A., D.Sc., M.D., F.Z.S.

On some Parasites of the Scoter Duck (*Edemia nigra*) and their relation to the Pearl-inducing Trematode in the Edible Mussel (*Mytilus edulis*).

G. A. BOULENGER, F.R.S., F.Z.S.

Descriptions of Three new Fishes discovered in the Gold Coast by Dr. H. G. F. Spurrell, M.A., F.Z.S.

The following papers have been received:—

G. W. SMITH, M.A., and E. H. J. SCHUSTER, M.A., D.Sc., F.Z.S.

The Genus *Engaeus*, or the Land Crayfishes of Australia.

The Hon. PAUL A. METHUEN, F.Z.S.

Description of an Amphipod belonging to the Family  
Talitridæ from the Woodbush, Transvaal.

Dr. F. D. WELCH.

Observations on living Specimens of the Capped Langur  
(*Semnopithecus pileatus*).

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Communications intended for the Scientific Meetings should  
be addressed to

P. CHALMERS MITCHELL,

*Secretary.*

ZOOLOGICAL SOCIETY OF LONDON,  
REGENT'S PARK, LONDON, N.W.

November 5th, 1912.

ABSTRACT OF THE PROCEEDINGS  
OF THE  
ZOOLOGICAL SOCIETY OF LONDON.\*

November 12th, 1912.

Dr. A. SMITH WOODWARD, F.R.S., Vice-President, in the Chair.

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The Minutes of the last Scientific Meeting were confirmed.

The SECRETARY read a report on the Additions that had been made to the Society's Menagerie during the month of October, 1912.

The SECRETARY exhibited a photograph of the Hainan Gibbon (*Hylobates hainanus*) in natural colours, taken by Messrs. Elliott & Fry, by the Lumière process.

Mr. G. A. BOULENGER, F.R.S., F.Z.S., exhibited a specimen, 155 mm. long, of the African Cichlid Perch (*Hemichromis bimaculatus* Gill), which had recently died in Capt. Vipan's aquarium. The specimen was remarkable for its large size. Although the species is common over a considerable part of Africa, and hundreds of specimens have been collected in various localities, no wild example is known to exceed a length of 100 mm.

This *Hemichromis* is tinged with bright red about the head and on the fins, and, as was noticed in the 'Fishes of the Nile,' p. 462, this red is soluble in spirit, which, a few hours after the immersion of the fish, acquires a bright orange-red colour.

Mr. EDWARD GERRARD exhibited the skull of an Indian Rhinoceros (*Rhinoceros unicornis*) which had recently died in the Society's Gardens. He pointed out that abscesses had been formed at the base of the lower incisors, which had been much

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rubbed down so that the nerves had become exposed. The animal must have suffered great pain, and this no doubt was the cause of his dashing his head against the walls and bars of his den in the violent manner he at times did.

Mr. E. G. BOULENGER, F.Z.S., Curator of Reptiles, exhibited a living specimen of the Salamander, *Amblystoma tigrinum*, which he had obtained from an Axolotl placed in special conditions with the object of forcing the metamorphosis.

Mr. D. SETH-SMITH, F.Z.S., Curator of Birds, gave a lantern demonstration of photographs of the young of Hemprich's Gull (*Larus hemprichi*), the Black-necked Swan (*Cygnus melanocephalus*), and the White Stork (*Ciconia alba*) which had been hatched in the Society's Gardens during the present year. He also showed slides of the nest, in a tree near the Apes' House, made by the Orang-utan which escaped from its cage on November 3rd, 1912.

Mr. H. R. HOGG, M.A., F.Z.S., read a paper entitled "Some Falkland Island Spiders," based on a small collection of Spiders formed by Mr. Rupert Vallentin during a two years' stay in the Falkland Islands.

Of some of the species there were a fair number of specimens, but they comprised only six species of Spiders and one of the allied suborder Opilio.

The species were all apparently new, but the genera were all to be found either in Patagonia, Tierra del Fuego, or the islands about Cape Horn. The ancestors of the Spiders might all have been transported aerially at an early period and therefore afforded no evidence for or against a former land-connection, but in the event of the latter there should be many more species. The Opilio might have been conveyed under the bark of floating trees.

Mr. G. A. BOULENGER, F.R.S., F.Z.S., read a short paper containing the descriptions of three new Fishes which had been discovered by Dr. Spurrell in the vicinity of Bibianaha, near Dunkwa, Gold Coast, and presented by him to the British Museum.

A paper was communicated by Dr. H. LYSTER JAMESON, M.A., Ph.D., F.Z.S., and Dr. WILLIAM NICOLL, M.A., D.Sc., F.Z.S., which contained an account of some parasites of the Scoter Duck (*Edemia nigra*), and discussed their relation to the pearl-inducing Trematode in the Edible Mussel (*Mytilus edulis*).

A paper was received from Mr. F. F. LAIDLAW, M.A., F.Z.S., dealing with some Dragonflies from Borneo belonging to the subfamily Corduliinae, and to the genera *Disparoneura* and

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